

VX-450 Series

VHF Band Service Manual

Motorola Solutions, Inc.

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EC094N91B

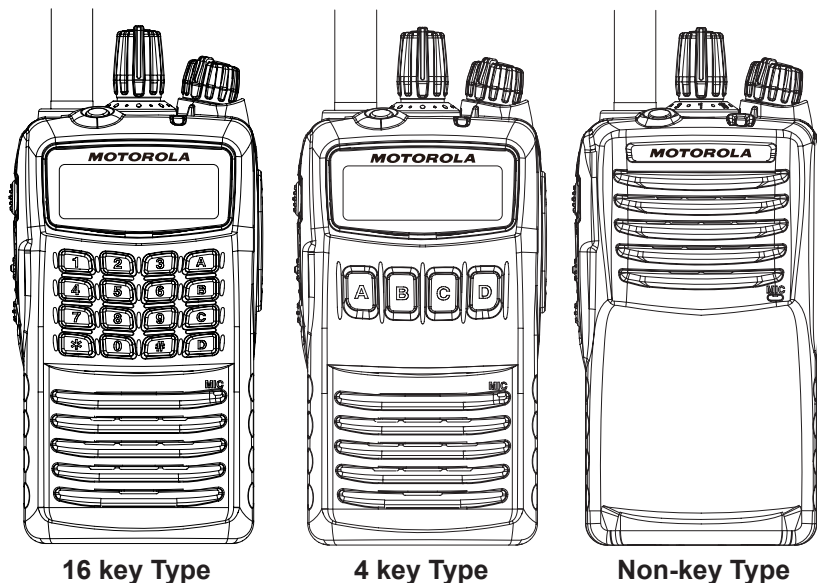
Introduction

This manual provides the technical information necessary for servicing the VX-450 Series Transceiver.

Servicing this equipment requires expertise in handling surface-mount chip components. Attempts by non-qualified persons to service this equipment may result in permanent damage not covered by the warranty, and may be illegal in some countries.

Two PCB layout diagrams are provided for each double-sided board in this transceiver. Each side of the board is referred to by the type of the majority of components installed on that side ("Side A" or "Side B"). In most cases one side has only chip components (surface-mount devices), and the other has either a mixture of both chip and leaded components (trimmers, coils, electrolytic capacitors, ICs, etc.), or leaded components only.

As described in the pages to follow, the advanced microprocessor design of the VX-450 Series Transceiver allows a complete alignment of this



16 key Type

4 key Type

Non-key Type

transceiver to be performed without opening the case of the radio; all adjustments can be performed from the front panel, using the "Alignment Mode" menu.

While we believe the information in this manual to be correct, Motorola Solutions assumes no liability for damage that may occur as a result of typographical or other errors that may be present. Your cooperation in pointing out any inconsistencies in the technical information would be appreciated.

Important Note

This transceiver is assembled using Pb (lead) free solder, based on the RoHS specification.

Only lead-free solder (Alloy Composition: Sn-3.0Ag-0.5Cu) should be used for repairs performed on this apparatus. The solder stated above utilizes the alloy composition required for compliance with the lead-free specification, and any solder with the above alloy composition may be used.

Contents

Specifications	2	Block Diagram.....	7
USA (NA) & Except EIA (CE) Models	2	16 key & 4 key Type	7
EIA (CE) Model.....	3	Non-key Type	11
Exploded View & Miscellaneous Parts	4	Circuit Description.....	15
16 key & 4 key Type	4	Alignment.....	18
Non-key Type	5	Board Units (Schematics)	
Parts List.....	6	MAIN Unit (16 key & 4 key Type).....	32
		MAIN Unit (Non-key Type).....	33
		Display Unit (16 key & 4 key Type)	34

Specifications: USA (NA) & Except EIA (CE) Models

General

Frequency range:	134-174 MHz
Channel / Group:	512 CH / 32 Groups (VX-459, VX-454) 32 CH / 2 Group (VX-451)
Power Supply Voltage:	7.4 V DC \pm 10 %
Current Consumption:	1.7 A (5 W TX)
Channel Spacing:	12.5 / 20 / 25 kHz
PLL Steps:	12.5 / 2.5 / 5 / 6.25 kHz
IP Rating:	IP57
Operating Temperature Range:	-22 °F to +140 °F (-30 °C to +60 °C)
Charging Temperature Range:	+32 °F to +113 °F (0 °C to +45 °C)
Frequency Stability:	\pm 2.5 ppm
RF Input-Output:	50 Ohms
Dimension (H x W x D):	4.3 x 2.3 x 1.3 inches (109 x 58.5 x 34 mm) (VX-451 with FNB-V112LI) 4.3 x 2.3 x 1.7 inches (109 x 58.5 x 43 mm) (VX-451 with FNB-V113LI) 4.3 x 2.3 x 1.4 inches (109 x 58.5 x 35 mm) (VX-451 with FNB-V133LI-UNI) 4.3 x 2.3 x 1.7 inches (109 x 58.5 x 43 mm) (VX-451 with FNB-V134LI-UNI) 4.3 x 2.3 x 1.4 inches (109 x 58.5 x 36 mm) (VX-454/-459 with FNB-V112LI) 4.3 x 2.3 x 1.8 inches (109 x 58.5 x 45 mm) (VX-454/-459 with FNB-V113LI) 4.3 x 2.3 x 1.5 inches (109 x 58.5 x 37 mm) (VX-454/-459 with FNB-V133LI-UNI) 4.3 x 2.3 x 1.8 inches (109 x 58.5 x 45 mm) (VX-454/-459 with FNB-V134LI-UNI)
Weight (Approx.):	10.4 oz (296 g) (VX-451 with FNB-V112LI, Antenna, Belt Clip) 12.0 oz (340 g) (VX-451 with FNB-V113LI, Antenna, Belt Clip) 9.9 oz (281 g) (VX-451 with FNB-V133LI-UNI, Antenna, Belt Clip) 11.6 oz (330 g) (VX-451 with FNB-V134LI-UNI, Antenna, Belt Clip) 11.4 oz (322 g) (VX-454/-459 with FNB-V112LI, Antenna, Belt Clip) 12.9 oz (366 g) (VX-454/-459 with FNB-V113LI, Antenna, Belt Clip) 10.8 oz (307 g) (VX-454/-459 with FNB-V133LI-UNI, Antenna, Belt Clip) 12.6 oz (356 g) (VX-454/-459 with FNB-V134LI-UNI, Antenna, Belt Clip)

Receiver (Measurement per TIA/EIA-603)

Circuit Type:	Double Conversion Super-heterodyne
Sensitivity (12dB SINAD):	0.25 μ V
Adjacent Channel Selectivity:	70/65 dB (W/N)
Hum and Noise:	45/40 dB (W/N)
Intermodulation:	70/65 dB (W/N)
Spurious Image Rejection:	70 dB
Audio output:	700 mW (internal @ 16 Ohms 5% THD) 500 mW (external @ 4 Ohms 5% THD)

Transmitter (Measurement per TIA/EIA-603)

Output Power:	5 / 2.5 / 1 / 0.25 W
Modulation:	16K0F3E/11K0F3E)
Maximum Deviation:	\pm 5.0 kHz / \pm 2.5 kHz
Conducted Spurious Emissions:	70 dB below carrier
FM Hum & Noise:	45 dB / 40 dB
Audio Distortion:	< 3% @ 1kHz

Specifications subject to change without notice or obligation.

Specifications: EIA (CE) Model

General

Frequency range:	134-174 MHz
Channel / Group:	512 CH / 32 Groups (VX-459, VX-454) 32 CH / 2 Group (VX-451)
Power Supply Voltage:	7.4 V DC \pm 10 %
Current Consumption:	1.7 A (5 W TX)
Channel Spacing:	12.5 / 20 / 25 kHz
PLL Steps:	12.5 / 2.5 / 5 / 6.25 kHz
IP Rating:	IP57
Operating Temperature Range:	-20 °C to +55 °C (-30 °C to +60 °C: Workable)
Charging Temperature Range:	+5 °C to +35 °C
Frequency Stability:	\pm 2.5 ppm
RF Input-Output:	50 Ohms
Dimension (H x W x D):	109 x 58.5 x 34 mm (VX-451 with FNB-V112LI) 109 x 58.5 x 43 mm (VX-451 with FNB-V113LI) 109 x 58.5 x 35 mm (VX-451 with FNB-V133LI-UNI) 109 x 58.5 x 43 mm (VX-451 with FNB-V134LI-UNI) 109 x 58.5 x 36 mm (VX-454/-459 with FNB-V112LI) 109 x 58.5 x 45 mm (VX-454/-459 with FNB-V113LI) 109 x 58.5 x 37 mm (VX-454/-459 with FNB-V133LI-UNI) 109 x 58.5 x 45 mm (VX-454/-459 with FNB-V134LI-UNI)
Weight (Approx.):	296 g (VX-451 with FNB-V112LI, Antenna, Belt Clip) 340 g (VX-451 with FNB-V113LI, Antenna, Belt Clip) 281 g (VX-451 with FNB-V133LI-UNI, Antenna, Belt Clip) 330 g (VX-451 with FNB-V134LI-UNI, Antenna, Belt Clip) 322 g (VX-454/-459 with FNB-V112LI, Antenna, Belt Clip) 366 g (VX-454/-459 with FNB-V113LI, Antenna, Belt Clip) 307 g (VX-454/-459 with FNB-V133LI-UNI, Antenna, Belt Clip) 356 g (VX-454/-459 with FNB-V134LI-UNI, Antenna, Belt Clip)

Receiver (Measurement per EN300 086)

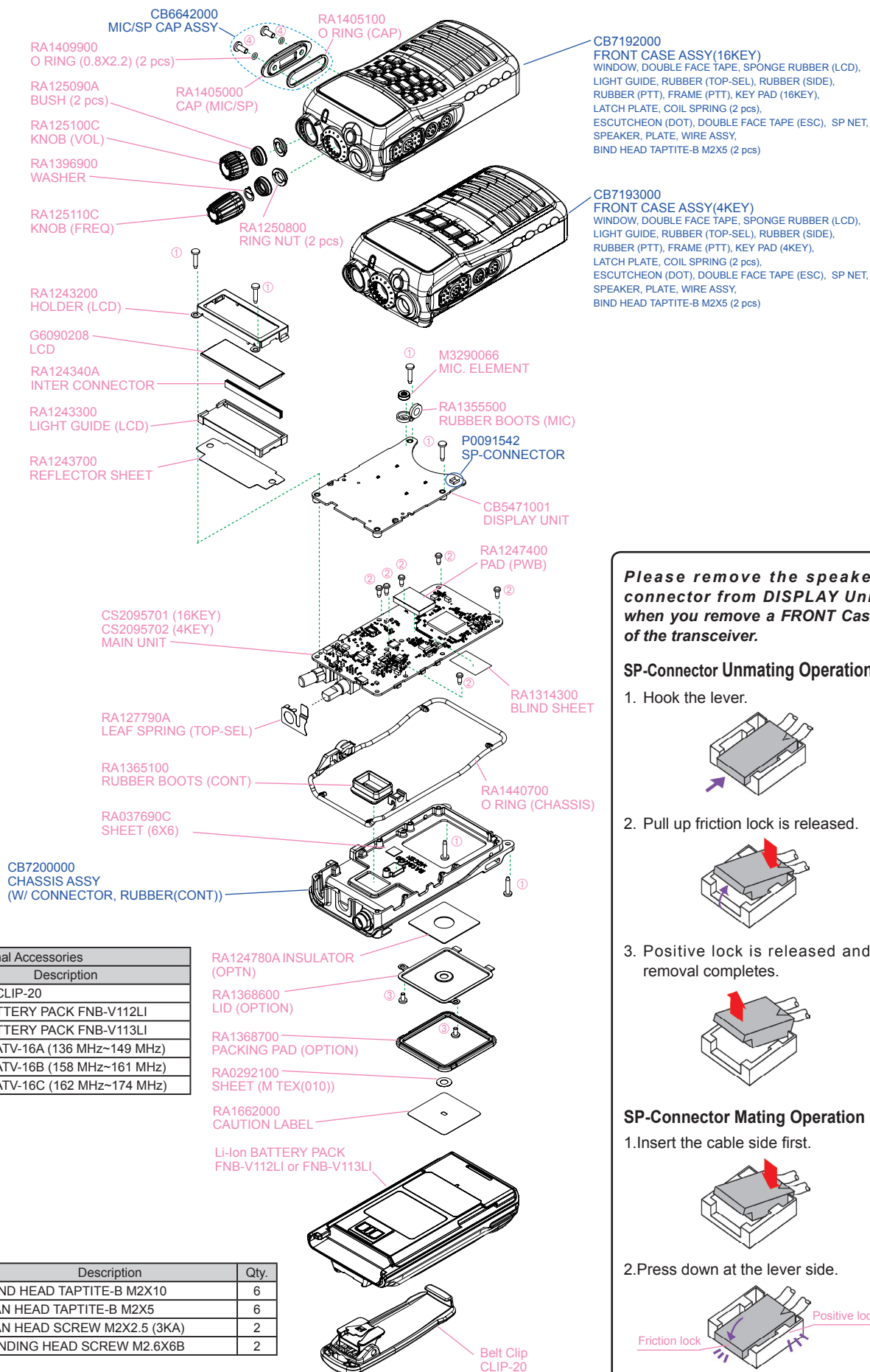
Circuit Type:	Double Conversion Super-heterodyne
Sensitivity (20 dB SINAD):	-2 dB μ V
Adjacent Channel Selectivity:	70/65 dB (W/N)
Hum and Noise:	45/40 dB (W/N)
Intermodulation:	70/65 dB (W/N)
Spurious Image Rejection:	70 dB
Audio output:	700 mW (internal @ 16 Ohms 5% THD) 500 mW (external @ 4 Ohms 5% THD)

Transmitter (Measurement per EN300 086)

Output Power:	5 / 2.5 / 1 / 0.25 W
Modulation:	16K0F3E/11K0F3E)
Maximum Deviation:	\pm 5.0 kHz / \pm 2.5 kHz
Spurious Emissions:	-36 dBm (< 1 GHz), -30 dBm (> 1 GHz)
FM Hum & Noise:	45 dB / 40 dB
Audio Distortion:	< 3% @ 1kHz

Specifications subject to change without notice or obligation.

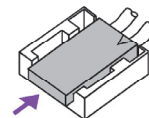
Exploded View & Miscellaneous Parts (16 key & 4 key Type)



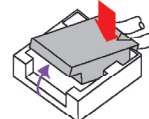
Please remove the speaker connector from DISPLAY Unit when you remove a FRONT Case of the transceiver.

SP-Connector Unmating Operation

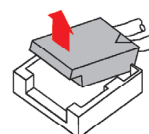
1. Hook the lever.



2. Pull up friction lock is released.

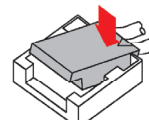


3. Positive lock is released and removal completes.

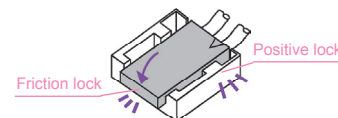


SP-Connector Mating Operation

1. Insert the cable side first.



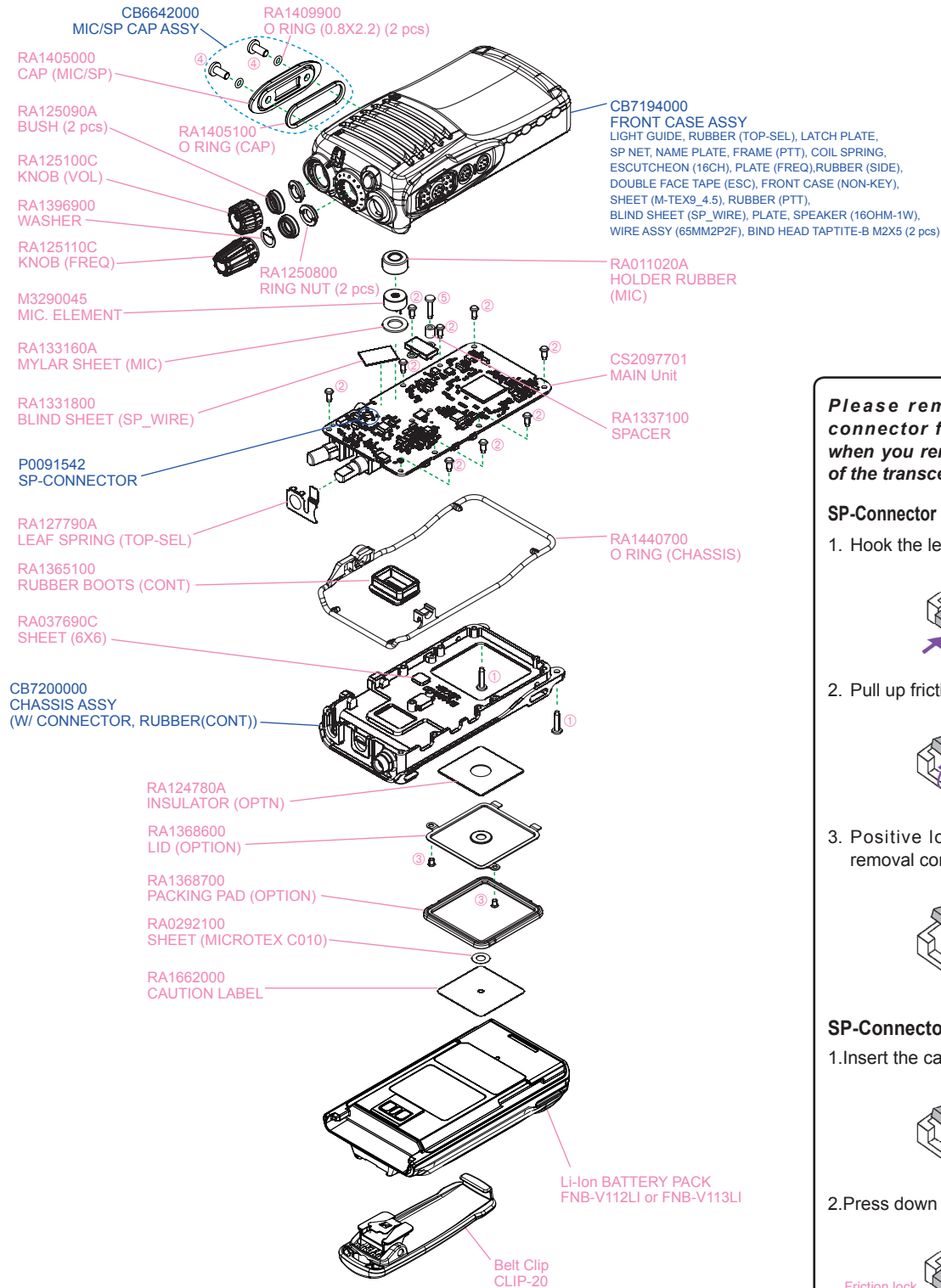
2. Press down at the lever side.



NOTE: Horizontal mating could damage the connector.

Non-designated parts are available only as part of a designated assembly.

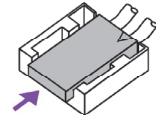
Exploded View & Miscellaneous Parts (Non-key Type)



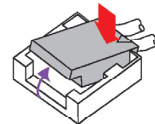
Please remove the speaker connector from DISPLAY Unit when you remove a FRONT Case of the transceiver.

SP-Connector Unmating Operation

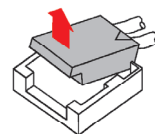
1. Hook the lever.



2. Pull up friction lock is released.

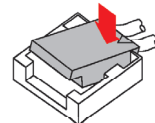


3. Positive lock is released and removal completes.

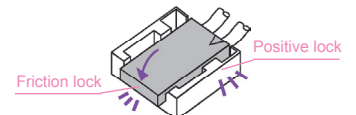


SP-Connector Mating Operation

1. Insert the cable side first.



2. Press down at the lever side.



NOTE: Horizontal mating could damage the connector.

Ref.	VXSTD P/N	Description	Qty.
①	U24110001	BIND HEAD TAPTITE-B M2X10	2
②	U44105001	PAN HEAD TAPTITE-B M2X5	6
③	U07225001	PAN HEAD SCREW M2X2.5 (3KA)	2
④	U20206007	BINDING HEAD SCREW M2.6X6B	2
⑤	U44110002	PAN HEAD TAPTITE-B M2X10NI	1

Non-designated parts are available only as part of a designated assembly.

Optional Accessories	
VXSTD P/N	Description
AAH12X501	Belt Clip CLIP-20
AAH07X501	Li-Ion BATTERY PACK FNB-V112LI
AAH08X501	Li-Ion BATTERY PACK FNB-V113LI
AAH73X502	Antenna ATV-16A (136 MHz~149 MHz)
AAH73X503	Antenna ATV-16B (158 MHz~161 MHz)
AAH73X504	Antenna ATV-16C (162 MHz~174 MHz)

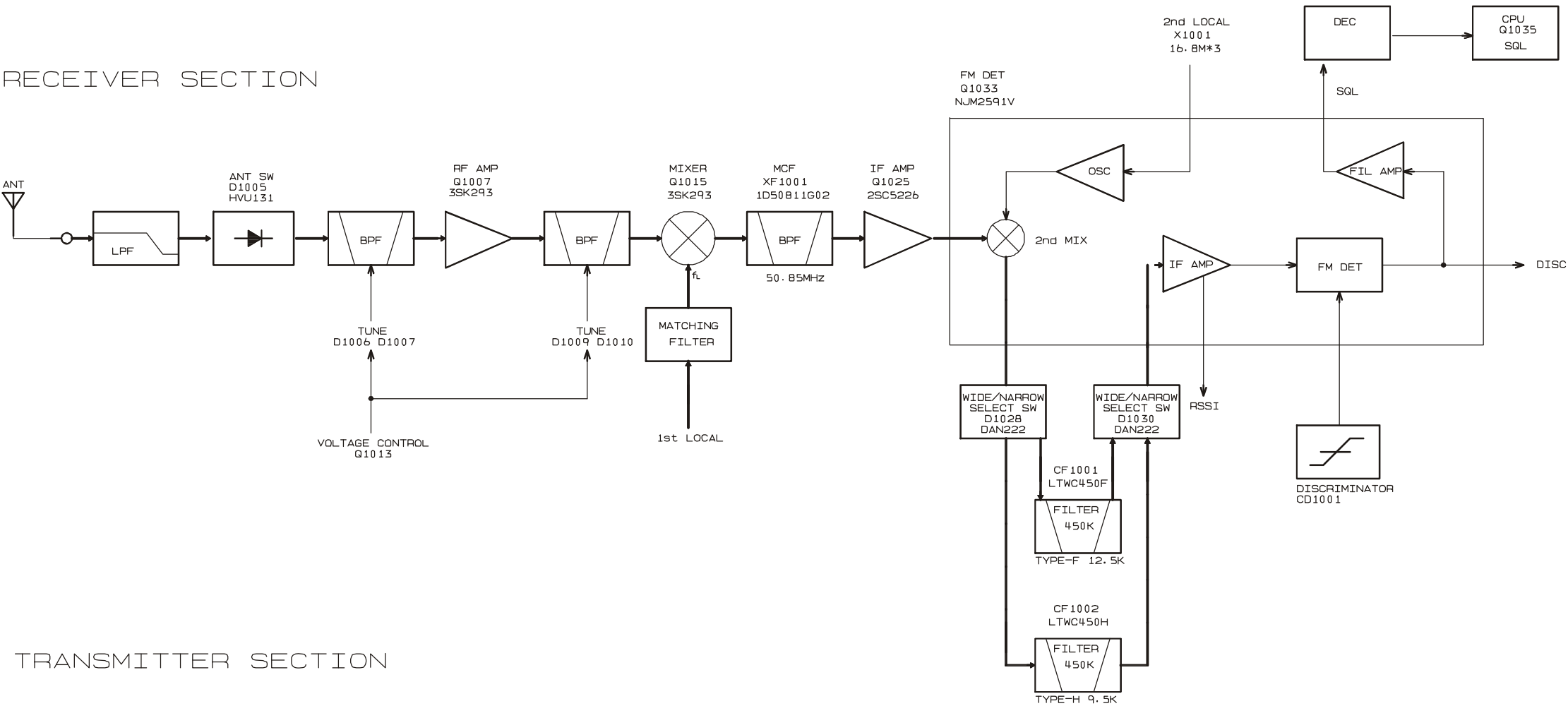
Parts List

REF.	DESCRIPTION	VALUE	V/W	TOL.	MFR'S DESIG	VXSTD P/N	VERS.	LOT.	SIDE	LAY ADR
PCB with Components										
MAIN UNIT						CS2095701	16 KEY			
						CS2095702	4 KEY			
						CS2097701	NON-KEY			
DISPLAY UNIT						CB5471001	16 KEY & 4 KEY			
Mechanical Parts										
FRONT CASE ASSY					(16KEY)	CB7192000	16 KEY			
FRONT CASE ASSY					(4KEY)	CB7193000	4 KEY			
FRONT CASE ASSY					(NON-KEY)	CB7194000	NON-KEY			
CHASSIS ASSY						CB7200000	16 KEY & 4 KEY, NON-KEY			
MIC/SP CAP ASSY						CB6642000				
	KNOB				(VOL)	RA125100C		1-		
	KNOB				(FREQ)	RA125110C		1-		
	SPEAKER				AC094U 36MM16OHM1W	M4090204		1-		
	HOLDER				(LCD)	RA1243200	16 KEY & 4 KEY	1-		
	LIGHT GUIDE				(LCD)	RA1243300	16 KEY & 4 KEY	1-		
	INTER CONNECTOR					RA124340A	16 KEY & 4 KEY	1-		
	SPONGE RUBBER				(LCD)	RA1243500	16 KEY & 4 KEY	1-		
	REFLECTOR SHEET					RA1243700	16 KEY & 4 KEY	1-		
	BINDING HEAD SCREW	2 pcs			M2.6X6B	U20206007		1-		
	BIND HEAD TAPTITE-B	6 pcs			2X10N	U24110001	16 KEY & 4 KEY	1-		
	BIND HEAD TAPTITE-B	2 pcs			2X10N	U24110001	NON-KEY	1-		
	BIND HEAD TAPTITE-B	2 pcs			M2X5 (SPEAKER)	U24105001		1-		
	PAN HEAD TAPTITE-B	6 pcs			M2X5	U44105001	16 KEY & 4 KEY	1-		
	PAN HEAD TAPTITE-B	9 pcs			M2X5	U44105001	NON-KEY	1-		
	PAN HEAD SCREW				M2X2.5(3KA)	U07225001		1-		
	PAN HEAD TAPTITE-B				M2X10	U44110002	NON-KEY	1-		
MAIN UNIT										
CD1001	CERAMIC DISC				ECDA450C24	H7901460		1-	B	c3
CF1001	CERAMIC FILTER				LTWC450F	H3900563		1-	B	c5
CF1002	CERAMIC FILTER				LTWC450H	H3900584		1-	B	c4
F 1001	CHIP FUSE	3.15A			FHC16 322ADTP	Q0000118		1-	A	B1
J 1008	CONNECTOR				DF57H-2P-1.2V(21)	P0091595	NON-KEY	1-	A	C2
MC1001	MIC. ELEMENT				PF0-1055P	M3290045	NON-KEY	1-	A	C3
Q 1006	FET				RQA0011DNS#G0	G3070507		1-	A	B2
S 1001	TACT SWITCH				EVQPUB02K	N5090167		1-	B	c1
S 1002	TACT SWITCH				EVQPUB02K	N5090167		1-	B	c2
S 1003	TACT SWITCH				EVQPUB02K	N5090167		1-	B	c3
S 1004	TACT SWITCH				EVQPUB02K	N5090167		1-	A	A1
S 1005	ROTARY SWITCH				TP7NBPC16 14.7F RY-10115	N0190198		1-	B	b1
SC1001	SHIELD CASE				(VCO)	RA1250300		1-	B	a3
TH1001	THERMISTOR				TH05 4B473FR	G9090150		1-	A	A5
VR1001	POT.				TP76N975N13.5FB503RY10034	J60800314		1-	B	a1
X 1001	TCXO	16.8MHz			TTS14VSB-A3 16.80MHZ	H9501100		1-	B	b4
X 1002	XTAL	32.768kHz			4809995L18 32.768KHZ	H0103407		1-	A	B4
XF1001	XTAL FILTER				1D50811GQ6 50.85M	H1102491		1-	B	c3
DISPLAY UNIT										
DS2001	LCD				GS-35719-TFZWH	G6090208	16 KEY & 4 KEY	1-	A	B1
J 2002	CONNECTOR				DF57H-2P-1.2V(21)	P0091595	16 KEY & 4 KEY	1-	A	A4
MC2001	MIC. ELEMENT				EM240T	M3290066	16 KEY & 4 KEY	1-	A	C4

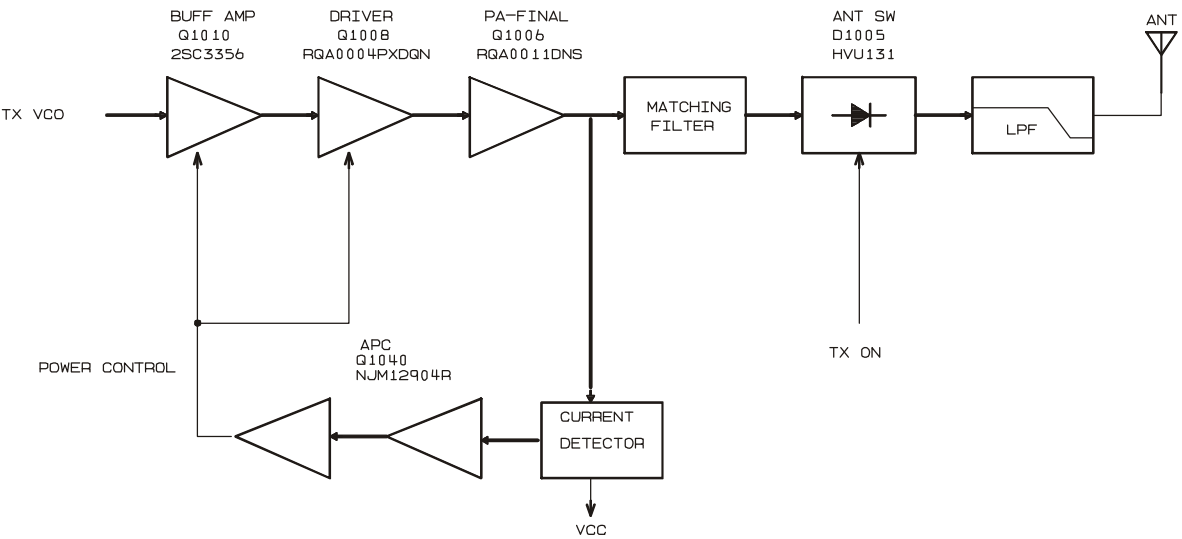
Block Diagram (16 key & 4 key Type)

AC094 RF BLOCK DIAGRAM
MAIN UNIT VHF

RECEIVER SECTION



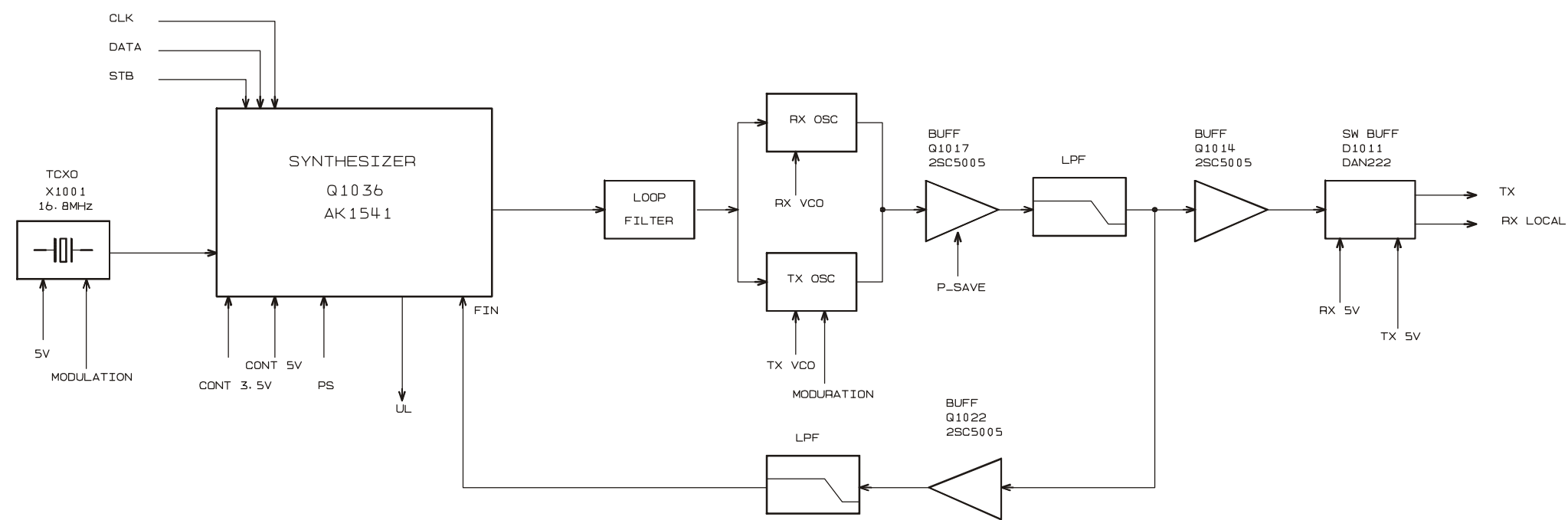
TRANSMITTER SECTION



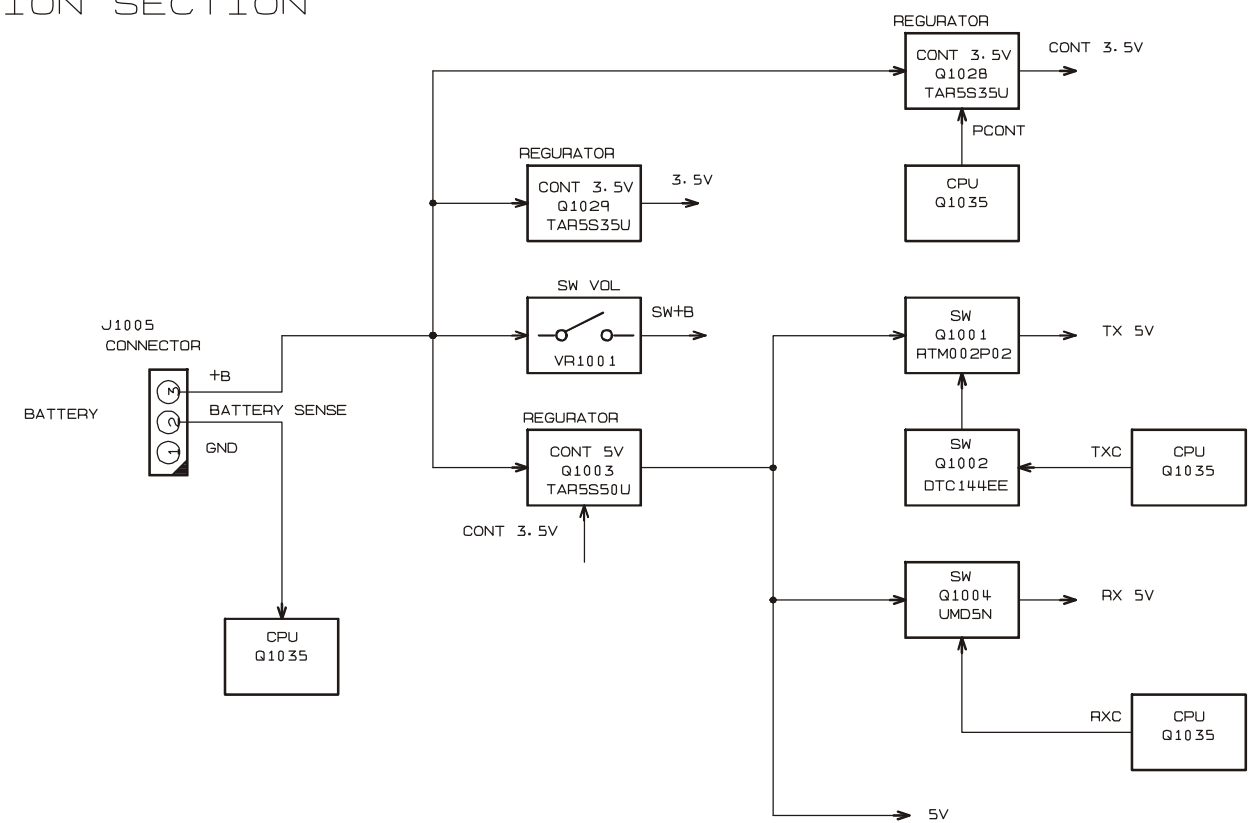
Block Diagram (16 key & 4 key Type)

AC094 FREQUENCY GENERATION & REGURATION BLOCK DIAGRAM
MAIN UNIT VHF

FREQUENCY GENERATION SECTION



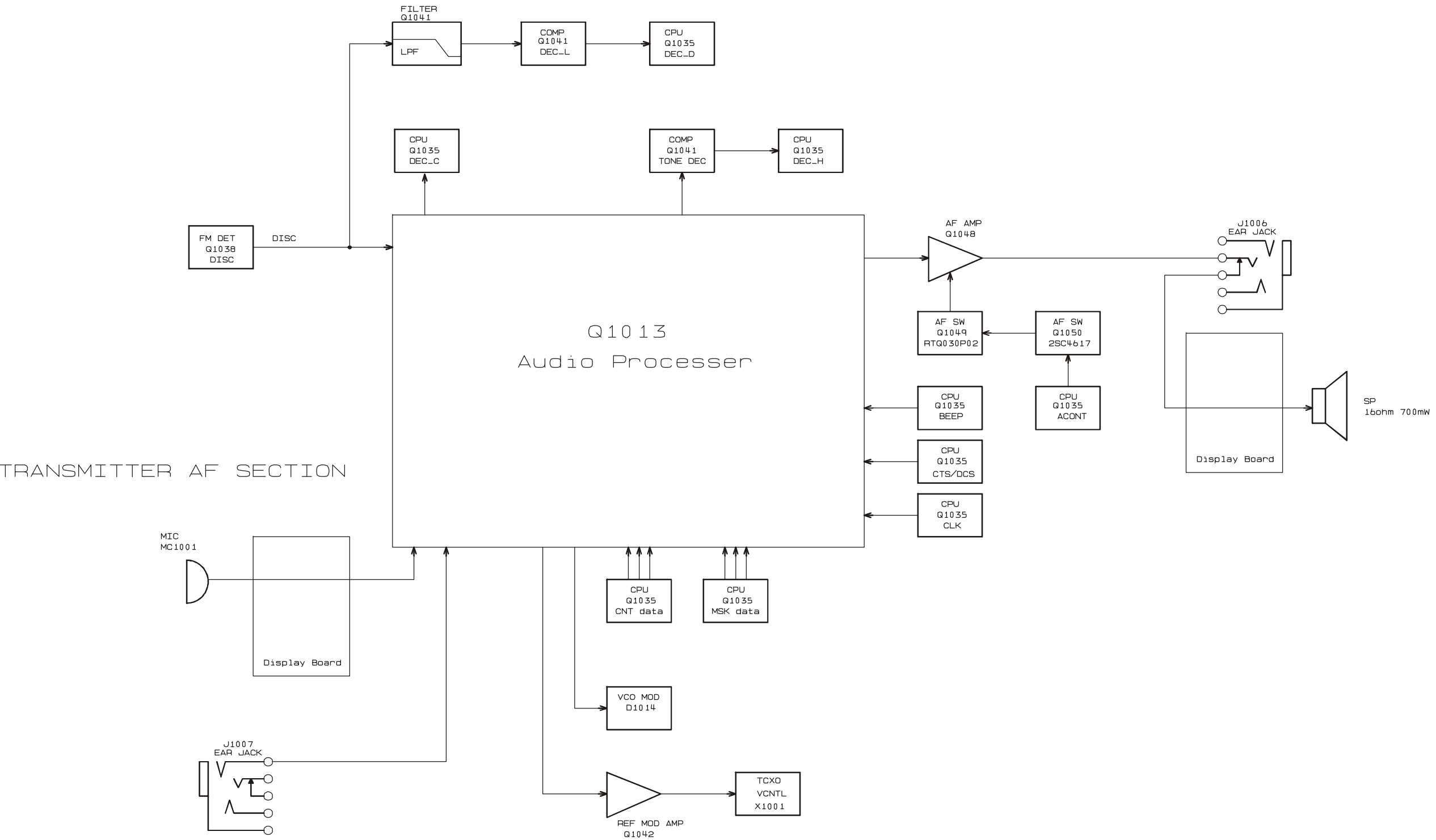
REGURATION SECTION



Block Diagram (16 key & 4 key Type)

AC094 AF BLOCK DIAGRAM
MAIN UNIT VHF

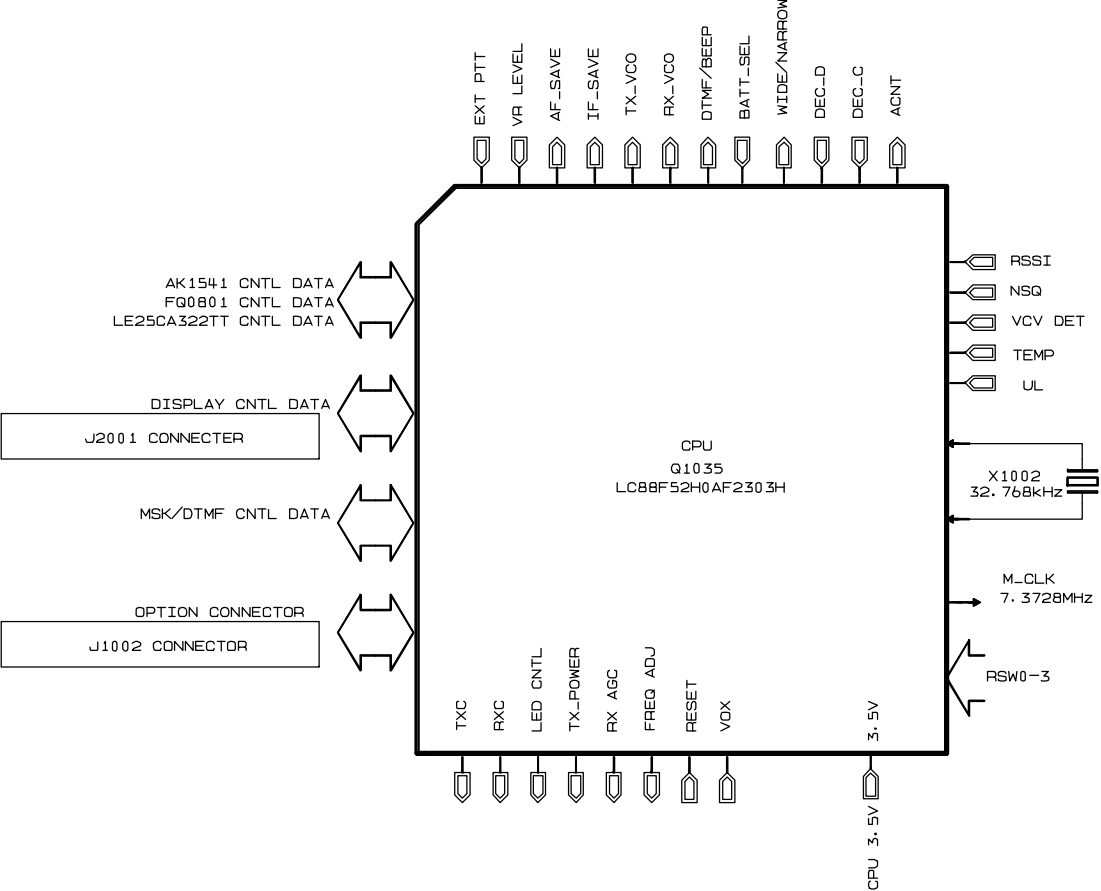
RECEIVER AF SECTION



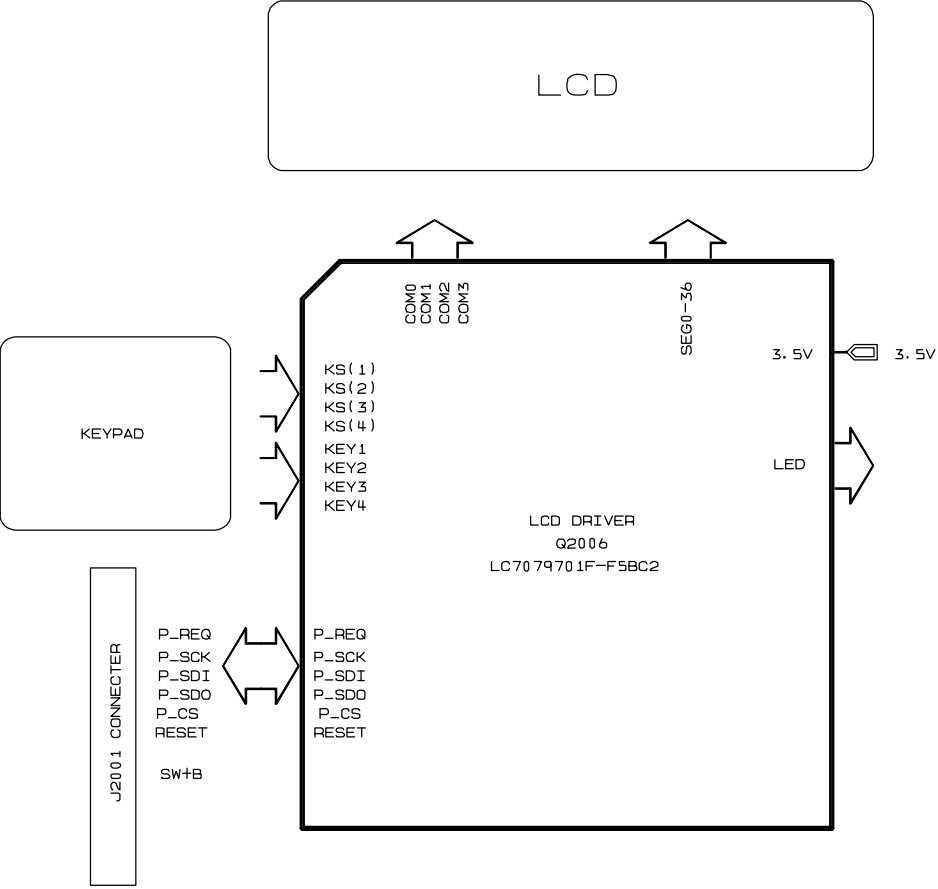
Block Diagram (16 key & 4 key Type)

AC094 CONTROL BLOCK DIAGRAM

MAIN UNIT



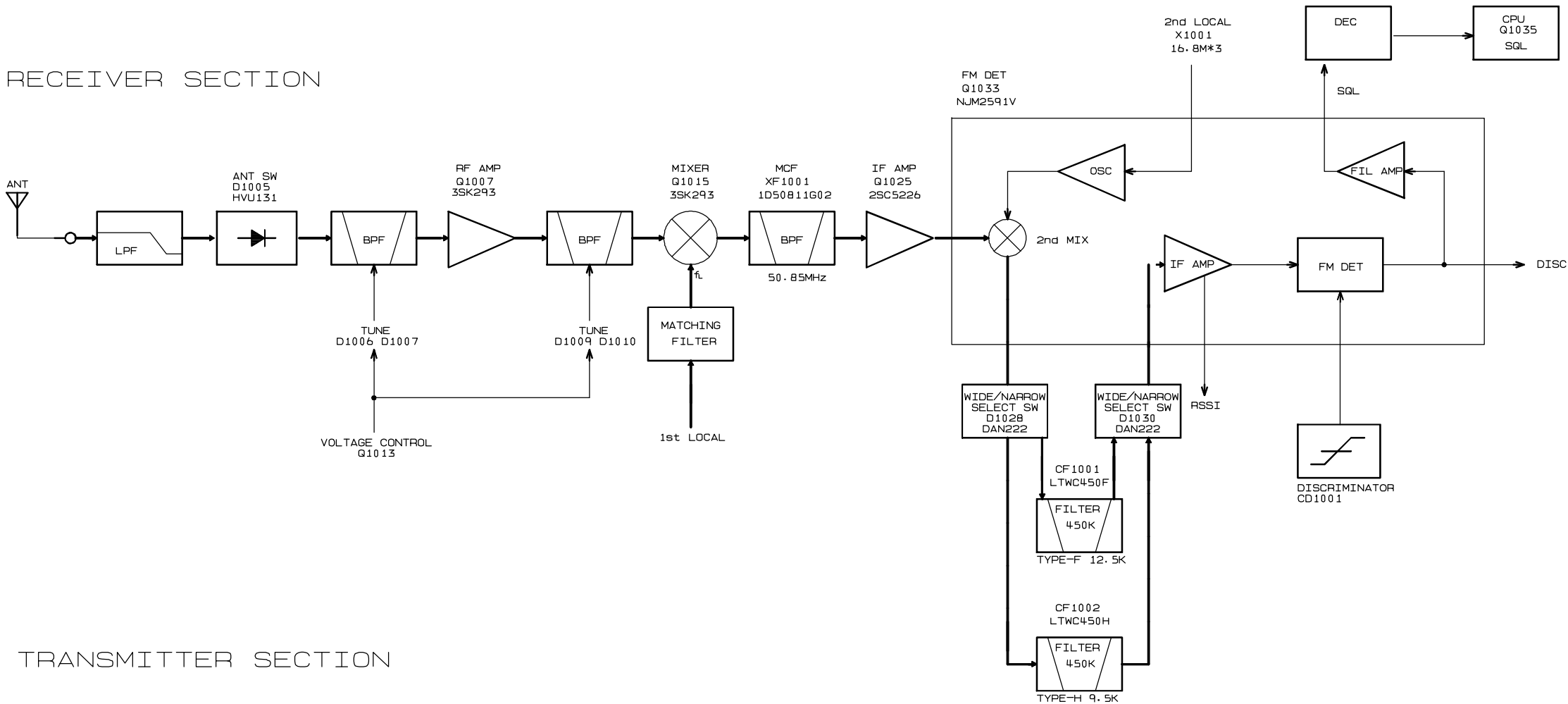
DISPLAY UNIT



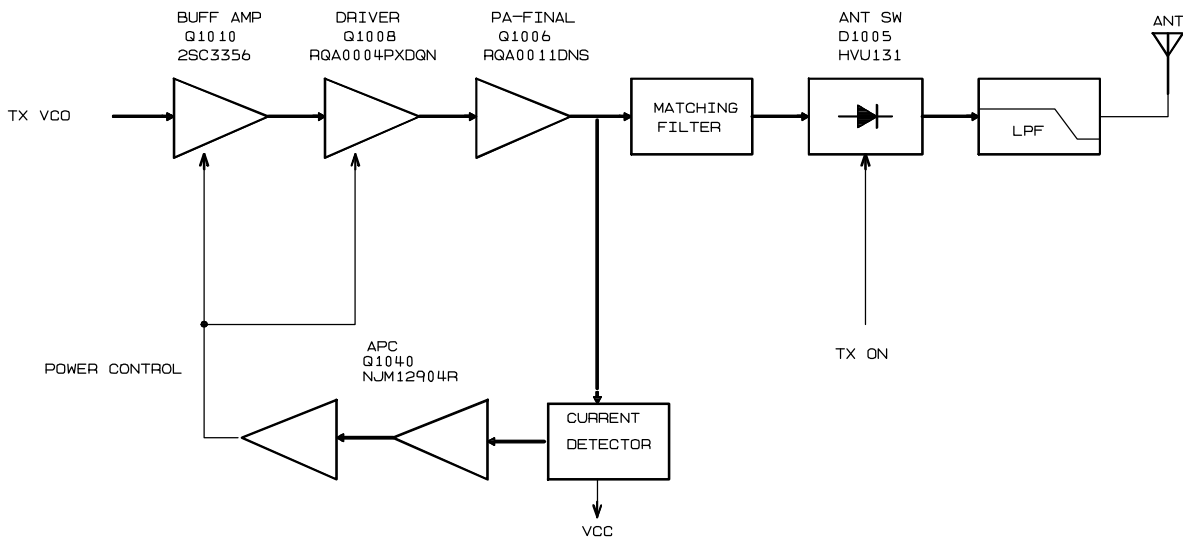
Block Diagram (Non-key Type)

AC095 RF BLOCK DIAGRAM
MAIN UNIT VHF

RECEIVER SECTION



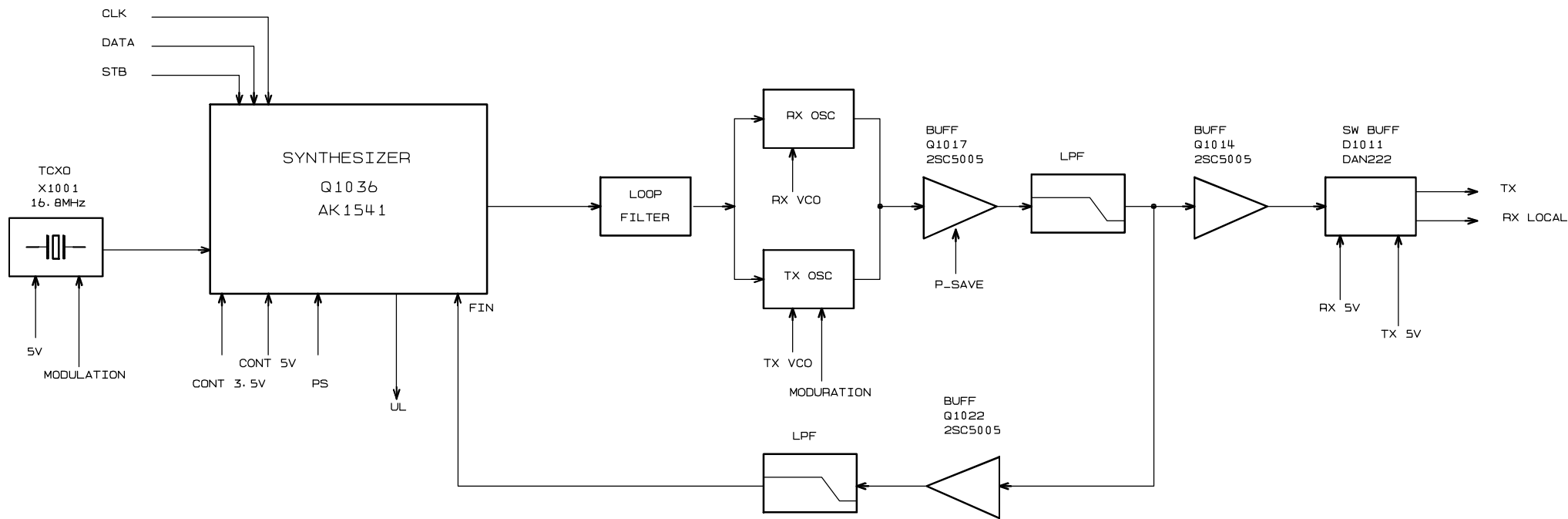
TRANSMITTER SECTION



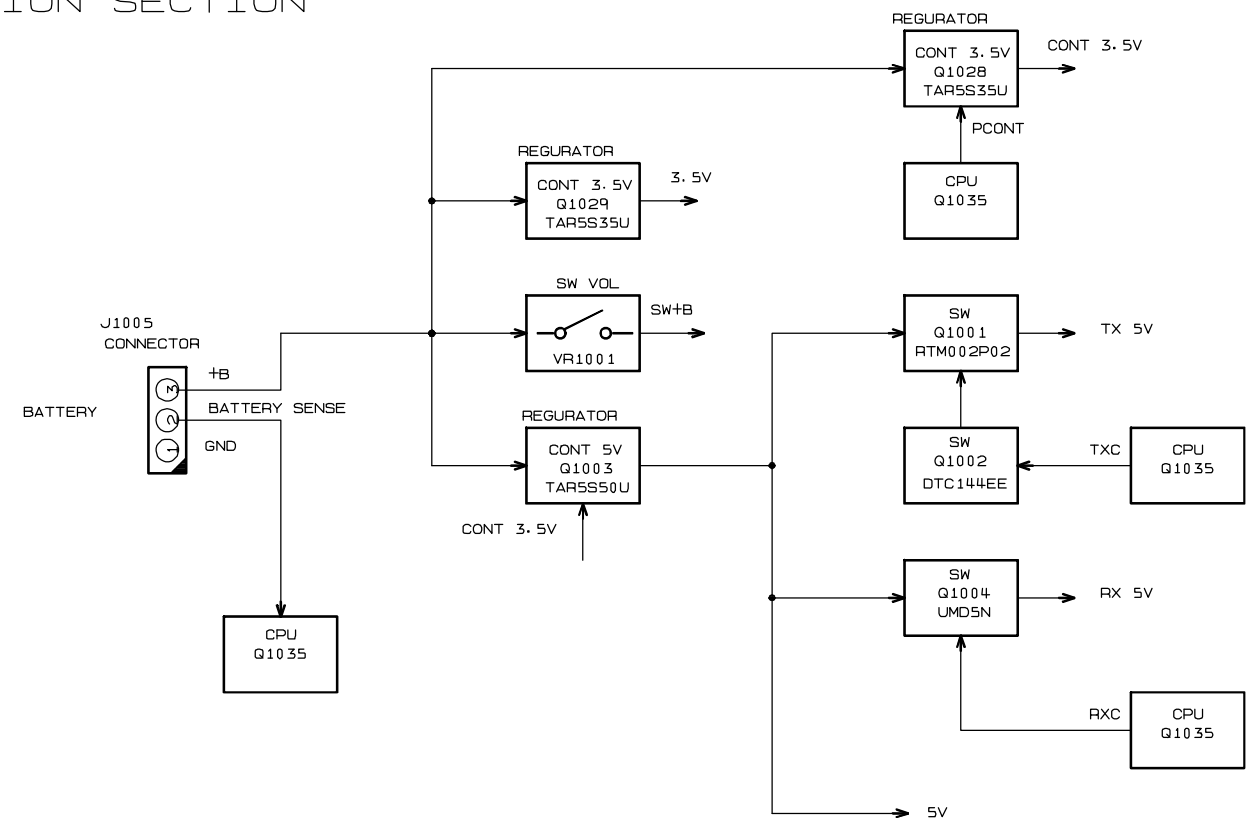
Block Diagram (Non-key Type)

AC095 FREQUENCY GENERATION & REGURATION BLOCK DIAGRAM
MAIN UNIT VHF

FREQUENCY GENERATION SECTION



REGURATION SECTION

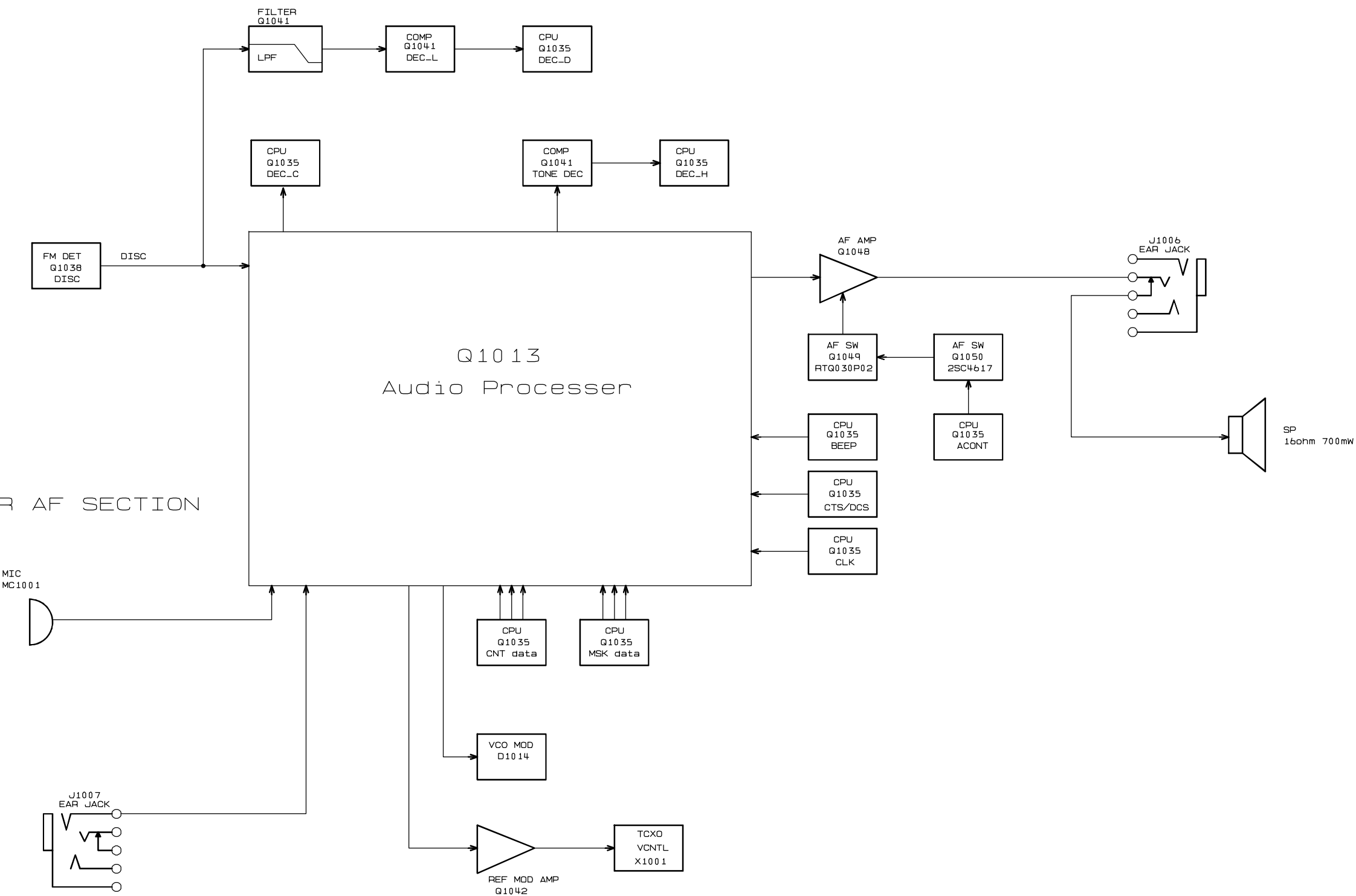


Block Diagram (Non-key Type)

AC095 AF BLOCK DIAGRAM
MAIN UNIT VHF

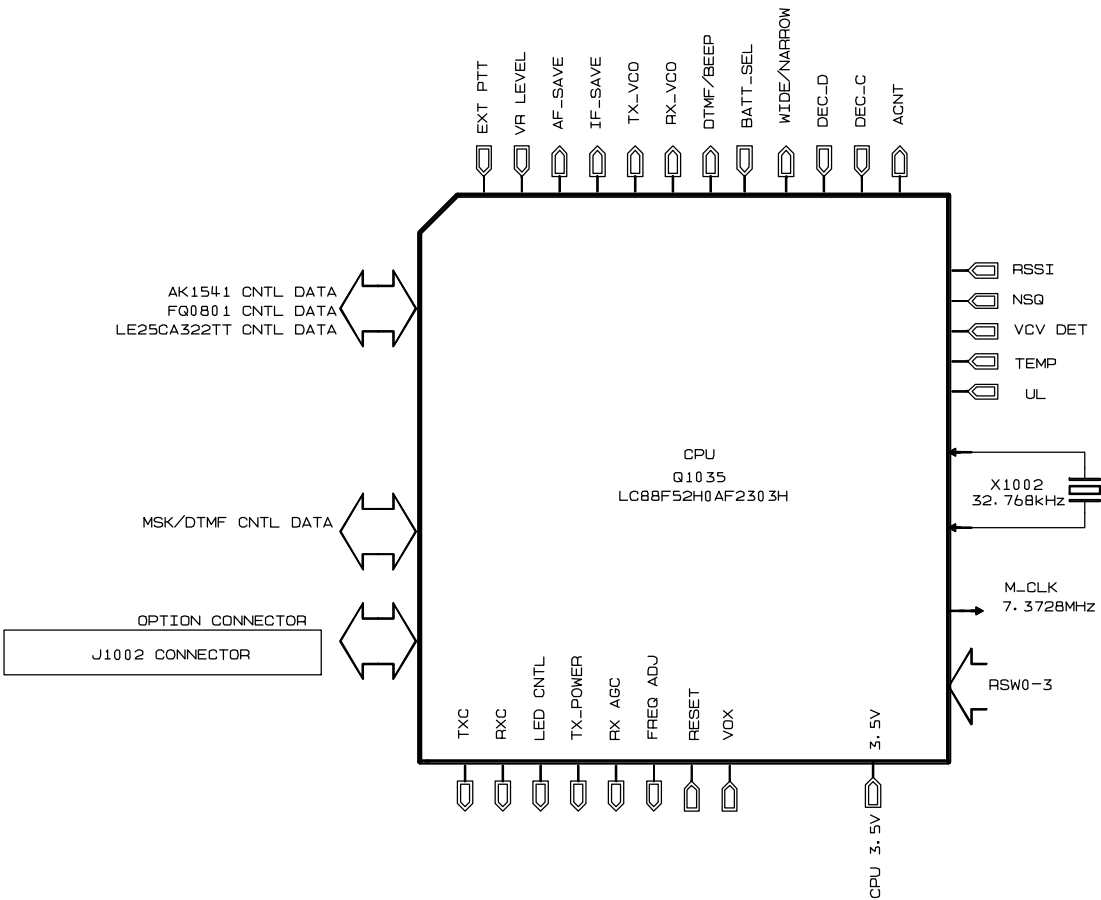
RECEIVER AF SECTION

TRANSMITTER AF SECTION



AC095 CONTROL BLOCK DIAGRAM

MAIN UNIT



Circuit Description

1. Circuit Configuration by Frequency

The receiver is a Double-conversion Super-heterodyne with a first intermediate frequency (IF) of 50.85MHz and a second IF of 450KHz. Incoming signal from the antenna is mixed with the local signal from the VCO/PLL to produce the first IF of 50.85 MHz.

This is then mixed with the 50.4 MHz second local oscillator output to produce the 450kHz second IF. This is detected to give the demodulated signal.

The transmit signal frequency is generated by the PLL VCO, and modulated by the signal from the microphone. It is then amplified and sent to the antenna.

2. Receiver System

2-1. Front-end RF amplifier

Incoming RF signal from the antenna is delivered to the RF Unit and passes through Low-pass filter, antenna switching diode, high pass filter and removed undesired frequencies by varactor diode **D1006**, **D1007** and **D1009**, **D1010** (tuned band-pass filter).

The passed signal is amplified in **Q1007 (2SK293)** and moreover cuts an image frequency with the tuned band pass filter and comes into the 1st mixer.

2-2. First Mixer

The 1st mixer consists of the **Q1015 (3SK293)**. Buffered output from the VCO is amplified by **Q1014 (2SC5005)** to provide a pure first local signal between 184.85 and 224.85 MHz for injection to the first mixer.

The IF signal then passes through monolithic crystal filters **XF1001** (± 7.5 kHz BW) to strip away all but the desired signal.

2-3. IF Amplifier

The first IF signal is amplified by **Q1025 (2SC5526)**. The amplified first IF signal is applied to FM IF subsystem IC **Q1033 (NJM2591V)** which contains the second mixer, second local oscillator, limiter amplifier, noise amplifier, and RSSI amplifier.

The signal from reference oscillator **X1001** becomes 4 times of frequencies in **Q1033**, it is mixed with the IF signal and becomes 450 kHz.

The second IF then passes through the ceramic filter **CF1001** or **CF1002** to strip away unwanted mixer

products, and is applied to the limiter amplifier in **Q1033**, which removes amplitude variations in the 450kHz IF, before detection of the speech by the ceramic discriminator **CD1001 (ECDA450C24)**.

2-4. Audio amplifier

Detected signal from **Q1033 (NJM2591V)** is inputted to Audio Processor IC **Q1013**.

The signal which appeared from **Q1001** is in high pass filter **Q1041 (NJM12902V)**.

The signal which passed **Q1041** goes to AF volume (VR1001). And then the signal goes to audio amplifier **Q1048 (TDA2822L-50B)**. The output signal from **J1006** is in audio speaker.

2-5. Squelch Circuit

There are 16 levels of squelch setting from 0 to 15. The level 0 means open the squelch. The level 1 means the threshold setting level and level 14 means tight squelch. From 2 to 13 is established in the middle of threshold and tight.

The bigger figure is nearer the tight setting. The level 15 becomes setting of carrier squelch.

2-5-1. Noise Squelch

Noise squelch circuit is composed of the band path filter and noise detector of **Q1033**.

When a carrier isn't received, the noise ingredient which goes out of the demodulator **Q1033** is amplified in **Q1037** through the band path filter, is detected to DC voltage with **D1031** and is inputted to 15 pin (the A/D port) of the **Q1035** (CPU).

When a carrier is received, the DC voltage becomes low because the noise is compressed.

When the detected voltage to CPU is high, the CPU stops AF output with **Q1049** "OFF" by making the 90 pin (CPU) "L" level.

When the detection voltage is low, the CPU makes **Q1049** ON with making 90 pin "H" and the AF signal is output.

2-5-2. Carrier Squelch

The CPU (14pin: A/D port) detect RSSI voltage output from **Q1033** 12 pin, and controls AF output.

The RSSI output voltage changes according to the signal strength of carrier. The stronger signal makes the RSSI voltage to be higher voltage.

Circuit Description

The process of the AF signal control is same as Noise Squelch.

The shipping data is adjusted -1dBu (EMF) higher than squelch tight sensitivity.

3. Transmitter System

3-1. MIC Amplifier

The AF signal from internal microphone **MC2001** or external microphone **J1004** in to Audio processor IC **Q1013**. (selected 34pin or 35pin) **Q1013** is which contains the microphone amplifier, compandor, Pre-emphasis, limiter and splatter filter, the processed signal to made FM modulation to transmit carrier by the modulator **D1014 (HVC383B)** of VCO.

Q1013 is DTMF Receiver, and Inversion Type Encryption.

3-2. Drive and Final Amplifier Stages

The modulated signal from the VCO **Q1023 (2SC4227)** is buffered by **Q1017 (2SC5005)**. Then the signal is buffered by **Q1010 (2SC3356)** for the final amplifier driver **Q1015 (RQA0004PXDQS)**. The low-level transmit signal is then applied to **Q1006 (RQA0011DNS)** for final amplification up to 5watts output power.

The transmit signal then passes through the antenna switch **D1005 (HVU131)** and is low pass filtered to suppress away harmonic spurious radiation before delivery to the antenna.

3-3. Automatic Transmit Power Control

The current detector **Q1040-1 (NJM12904V)** detects the current of **Q1006** and **Q1008**, and converts the current difference to the voltage difference.

The output from the current detector **Q1040-1** is compared with the reference voltage and amplified by the power control amplifier **Q1040-2**.

The output from **Q1040-2** controls the gate bias of the final amplifiers **Q1006** and the final amplifier driver **Q1008**.

The reference voltage changes into four values (Transmit Power High and Low) controlled by **Q1040 (NJM12904V)**.

4. PLL Frequency Synthesizer

The frequency synthesizer consists of PLL IC, **Q1036 (AK1541)**, VCO, TCXO (**X1001**).

The output frequency from TCXO is 16.8 MHz and the tolerance is +/- 2.5 ppm (in the temperature range -30 to +60 degrees).

4-1. VCO (TX Voltage-Controlled Oscillator)

While the radio is receiving, the RX oscillator **Q1019 (2SK508)** in VCO generates a programmed frequency between 201.65 and 241.65MHz as 1st local signal.

While the radio is transmitting, the TX oscillator **Q1023 (2SC4227)** in VCO generates a frequency between 134 and 174 MHz.

The output from oscillator is amplified by buffer amplifier **Q1017 (2SC5005)** and becomes output of VCO. The output from VCO is divided, one is amplified by **Q1022** and feed back to the PLL IC 17 pin. The other is amplified in **Q1014** and in case of the reception, it is put into the mixer as the 1st local signal through **D1011**, in transmission, it is buffered **Q1010**, and more amplified in **Q1008** and it is put into the final amplifier **Q1008**.

4-2. VCV (Varactor Control Voltage) Control

Tuning voltage of VCO is expanding the lock range of VCO by controlling the cathode of varactor diode at the voltage and the control voltage from PLL IC.

4-3. PLL

The PLL IC consists of reference divider, main divider, phase detector, charge pumps and pulse swallow operation. The reference frequency from TCXO is inputted to 10 pin of PLL IC and is divided by reference divider.

The other hand, inputted feed back signal to 17 pin of PLL IC from VCO is divided with the dividing ratio which becomes same frequency as the output of reference divider. These two signals are compared by phase detector, the phase difference pulse is generated.

The phase difference pulse and the pulse from through the charge pumps and LPF. It becomes the DC voltage to control the VCO.

The oscillation frequency of VCO is locked by the control of this DC voltage.

Circuit Description

The PLL serial data from CPU is sent with three lines of SDO (40pin), SCK (36pin) and PSTB (30pin).

The lock condition of PLL is output from the UL (18Pin) terminal and UL becomes "H" at the time of the lock condition and becomes "L" at the time of the unlocked condition. The CPU always watches over the UL condition, and when it becomes "L" unlocked condition, the CPU prohibits transmitting and receiving.

Alignment

Introduction

The **VX-450** series is carefully aligned at the factory for the specified performance across the frequency range specified for each version. Realignment should therefore not be necessary except in the event of a component failure, or altering version type. All component replacement and service should be performed only by an authorized **Motorola Solutions** representative, or the warranty policy may be void.

The following procedures cover the sometimes critical and tedious adjustments that are not normally required once the transceiver has left the factory. However, if damage occurs and some parts subsequently are replaced, realignment may be required. If a sudden problem occurs during normal operation, it is likely due to component failure; realignment should not be done until after the faulty component has been replaced.

We recommend that servicing be performed only by authorized **Motorola Solutions** service technicians who are experienced with the circuitry and fully equipped for repair and alignment. Therefore, if a fault is suspected, contact the dealer from whom the transceiver was purchased for instructions regarding repair. Authorized **Motorola Solutions** service technicians realign all circuits and make complete performance checks to ensure compliance with factory specifications after replacing any faulty components.

Those who do undertake any of the following alignments are cautioned to proceed at their own risk. Problems caused by unauthorized attempts at realignment are not covered by the warranty policy. Also, **Motorola Solutions** reserves the right to change circuits and alignment procedures in the interest of improved performance, without notifying owners.

Under no circumstances should any alignment be attempted unless the normal function and operation of the transceiver are clearly understood, the cause of the malfunction has been clearly pinpointed and any faulty components replaced, and realignment determined to be absolutely necessary.

The following test equipment (and thorough familiarity with its correct use) is necessary for complete realignment. Correction of problems caused by misalignment resulting from use of improper test equipment is not covered under the warranty policy. While most steps do not require all of the equipment listed, the interactions of some adjustments may require that more complex adjustments be performed afterwards. Do not attempt to perform only a single step unless it is clearly isolated electrically from all other steps. Have all test equipment ready before beginning, and follow all of the steps in a section in the order presented.

Required Test Equipment

- ☐ RF Signal Generator with calibrated output level at 200 MHz
- ☐ Oscilloscope
- ☐ Deviation Meter (linear detector)
- ☐ In-line Wattmeter with 5 % accuracy at 200 MHz
- ☐ 50 Ohm RF Dummy Load with power rating 10 W at 200 MHz
- ☐ 4 Ohm/1W AF Dummy Load (*Attention : Audio output is BTL output*)
- ☐ Regulated DC Power Supply (standard 7.5 V DC, 3 A)
- ☐ Frequency Counter with 0.2 ppm accuracy at 200 MHz
- ☐ Audio Signal Generator
- ☐ AC Voltmeter
- ☐ DC Voltmeter
- ☐ VHF Sampling Coupler
- ☐ IBM® PC/compatible Computer with Microsoft® Windows® 2000, XP, Vista or Windows7
- ☐ Motorola Solutions CE115 PC Programming Software
- ☐ Motorola Solutions FIF-12 USB Programming Interface and CT-104A, CT-106, or CT-171 PC Programming Cable
- ☐ Motorola Solutions FRB-6 Tuning Interface Box and CT-160 Connection Cable
- ☐ CN-2A (P/N: A08420002) Antenna Connector

Alignment

Alignment Preparation & Precautions

A 50-Ohm RF Dummy Load and in-line wattmeter must be connected to the main antenna jack in all procedures that call for transmission, except where specified otherwise. Correct alignment is not possible with an antenna.

Because of the BTL (Bridged Trans Less) Amplifier circuit used in the **VX-450** series, do not connect earth side of the speaker leads to chassis "ground".

After completing one step, read the following step to determine whether the same test equipment will be required. If not, remove the test equipment (except dummy load and wattmeter, if connected) before proceeding.

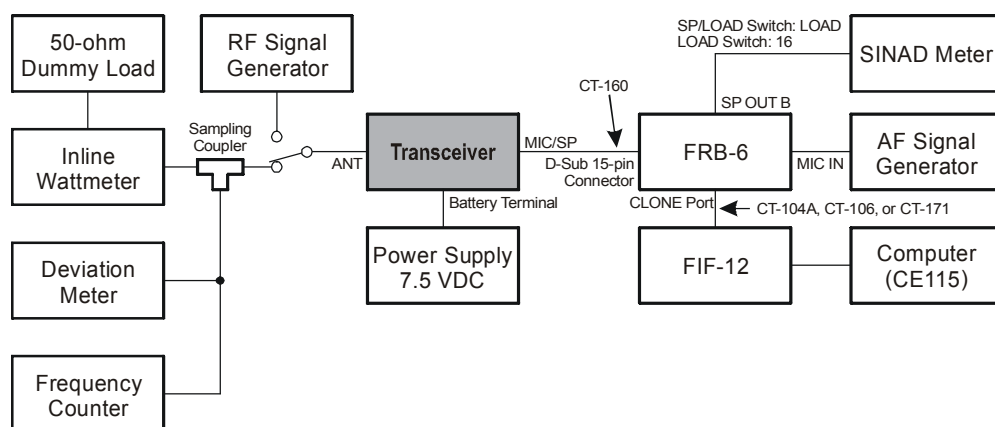
Correct alignment requires that the ambient temperature be the same as that of the transceiver and test equipment, and that this temperature be held constant between 68 and 86 °F (20 ~ 30 °C). When the transceiver is brought into the shop from hot or cold air, it should be allowed time to come to room temperature before alignment.

Whenever possible, alignments should be made with oscillator shields and circuit boards firmly affixed in place. Also, the test equipment must be thoroughly warmed up before beginning.

Note: Signal levels in dB referred to in the alignment procedure are based on $0\text{ dB}\mu\text{ EMF} = 1\text{ }\mu\text{V}$.

Test Setup

Setup the test equipment as shown for transceiver alignment, apply 7.5 V DC power to the transceiver. Refer to the drawings above for Alignment Points.



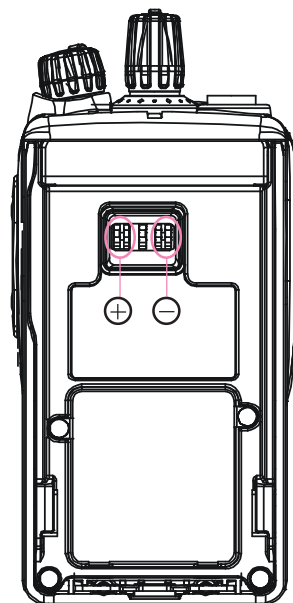
The Alignment Tool Outline

Installation the tool

- ❑ Install the CE115 (PC Programming Software) to your PC.
- ❑ "Alignment" function in the "Radio" menu of CE115.

Action of the switches

When the transceiver is in the "Alignment mode," the action of the PTT and all PF KEYS are ignored. All of the action is controlled by the PC.



BATTERY TERMINAL POLARITY

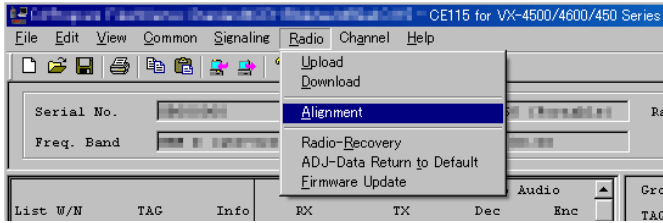
Caution!

Please never turn off a power supply while alignment. If the power supply turn off while alignment, the setting data is failed.

Alignment

Alignment Mode

The Alignment mode allows you to align the entire radio. The value of each parameter can be changed to the desired value by use of the “←” / “→” and up/down arrow keys, along with direct number input and dragging of the PC mouse.



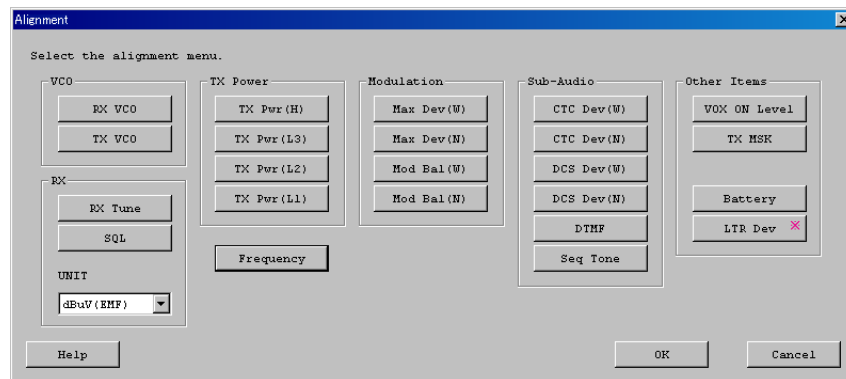
To enter the Alignment Mode, select “Alignment” in the main “Radio” menu. It will start to “Upload” the alignment data from the radio to the PC. Pressing the “OK” button will then “Download” the alignment data to the radio and exit the Alignment Mode.

Note: when all items are to be aligned, it is strongly recommended to align them according to the following sequence. Detailed information for each step may be found in the “Help” file within CE115 (PC Programming Software).

1. VCO (*Please do not adjust it*)
2. PLL Reference Frequency (Frequency)
3. RX Sensitivity (RX Tune)
4. Squelch (SQL/RSSI)
5. TX Power <High/Low3/Low2/Low1>
6. Maximum Deviation <Wide/Narrow>

Please adjust the following items when needed.

- ☐ Modulation Balance <Wide/Narrow>
- ☐ CTCSS Deviation <Wide/Narrow>
- ☐ DCS Deviation <Wide/Narrow>
- ☐ DTMF Alignment
- ☐ Seq Tone
- ☐ VOX ON Level
- ☐ TX MSK
- ☐ LTR Deviation✕
- ☐ Battery

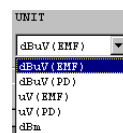
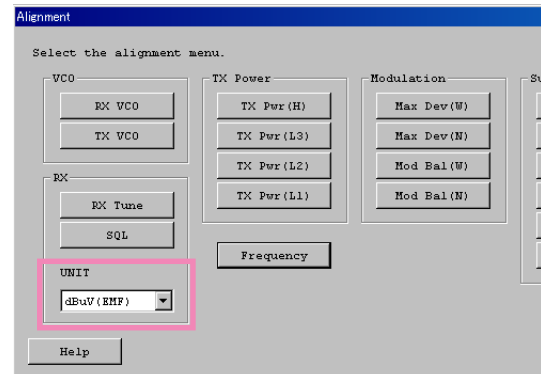


✕ The “LTR Dev” parameter does not appear when adjusting the transceiver which is not installed the LTR feature.

Unit

During alignment, you may select the value among dB μ V, μ V (EMF or PD), or dBm.

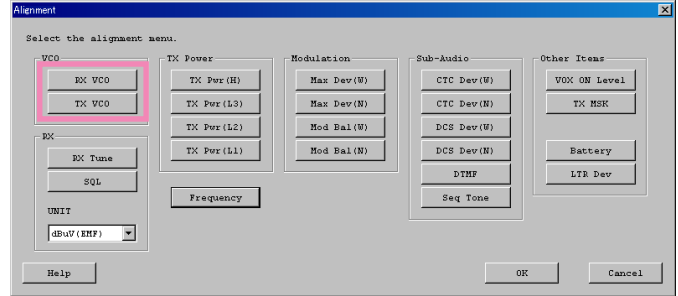
When performing the “RX Tune” and “SQL” alignment, the RF level shows this unit according to this setting.



Alignment

1. VCO (RX VCO/TX VCO) - Normally there is no need to adjust this parameter -

This parameter is to align the VCO Voltage adjustment.



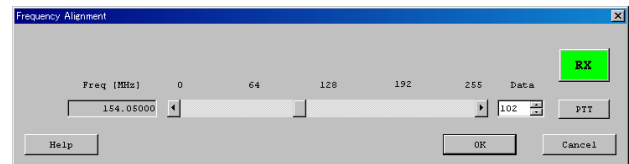
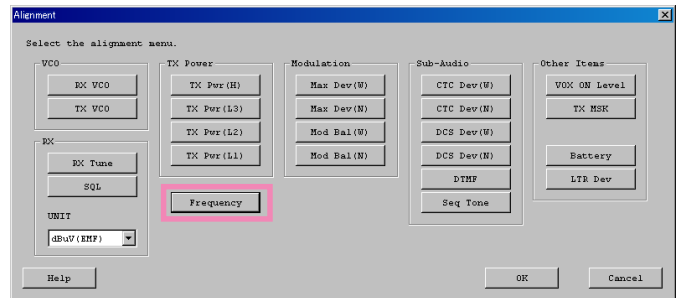
2. PLL REFERENCE FREQUENCY (FREQUENCY)

This parameter is to align the reference frequency for PLL.

1. Press the “Frequency” button to start the alignment.

The Frequency Alignment window will appear.

2. Click the “PTT” button or press the “SPACE” bar, and the radio will start to transmit on the center frequency channel.
3. Set the value to get the desired frequency by dragging the slide bar, clicking the up-down button, pressing the left or right arrow key, or entering the value in the entry box.
4. After getting the desired frequency click the “PTT” button or press the “SPACE” bar to stop transmitting.
5. Click the “OK” button to finish the frequency alignment and save the data.



Alignment

3. RX SENSITIVITY (RX TUNE)

This parameter is to align the RX BPF (Band Pass Filter) for Receive (RX) sensitivity. The PLL Reference Frequency (Frequency) alignment must be done before this alignment is performed.

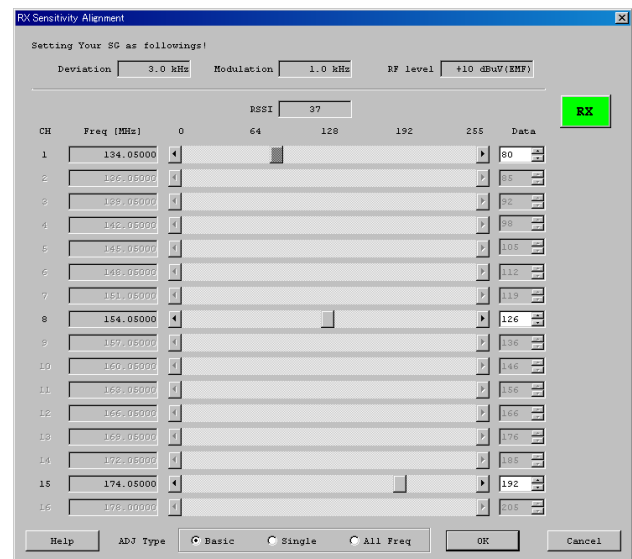
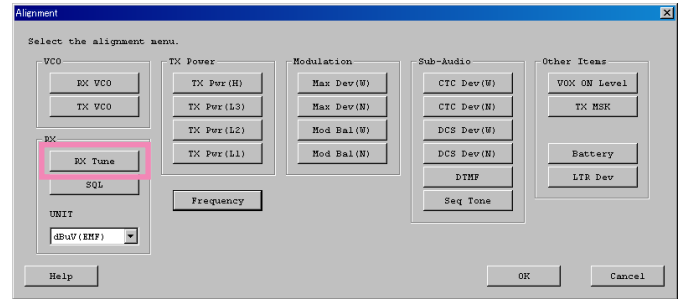
1. Press the “RX Tune” button to start the alignment.
The RX Sensitivity Alignment window will appear.
2. Click the left mouse button on the slide bar or press Up / Down arrow key, to switch to the selected channel.
3. Set the Signal Generator according to the indication at the top of the screen (Setting Your SG as followings).
4. Drag the slide bar, click the up-down buttons, press the left or right arrow key, or enter the value in the entry box to get the best RX sensitivity (Highest RSSI value).
5. Click the “OK” button to finish the RX Sensitivity alignment and save the data.

ADJ Type

Basic: “Low-edge / band center / high-edge” and select the channel for alignment (Default).

Single : Alignment value changes only on the selected channel.

All Freq : Alignment value changes on all channels.



Alignment

4. SQUELCH (SQL)

This parameter is to align the SQL (Squelch) Sensitivity.

There are several alignments as follows in the Squelch Sensitivity.

Tight SQL Level (TI NSQ W/N)

The Alignment for the Noise SQL Tight level at Wide (5k/4k) or Narrow (2.5k).

Threshold SQL Level (TH NSQ W/N)

The Alignment for the Noise SQL Threshold level at Wide (5k/4k) or Narrow (2.5k).

Tight SQL RSSI Level (TI RSSI W/N)

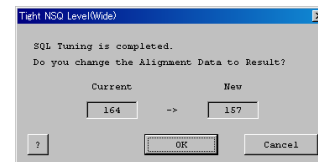
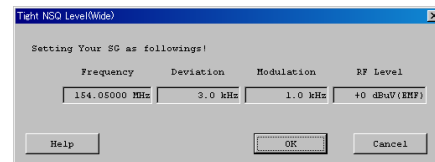
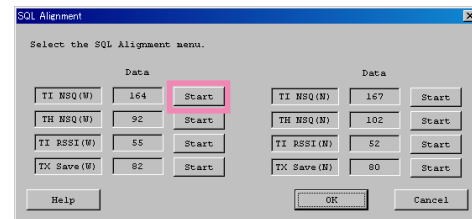
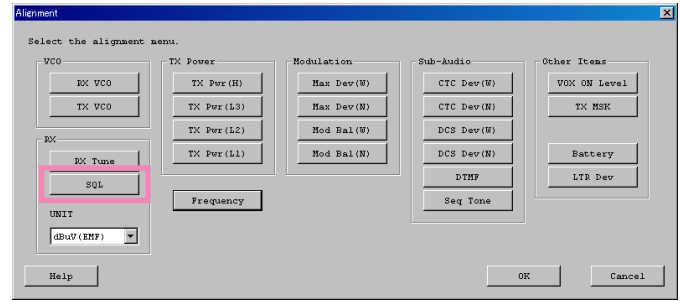
The Alignment for the “level 15” of the RSSI SQL level at Wide (5k/4k) or Narrow (2.5k).

TX Save RSSI Level (TX SAVE W/N)

The Alignment for the TX Save RSSI level at Wide (5k/4k) or Narrow (2.5k).

The procedure for all the alignments is as follows.

1. Click the “Start” button to open the alignment window in the SQL/RSSI Alignment menu.
2. The Alignment window will appear, Set the Signal Generator according to the indication, then click the “Start” button.
3. The automatic alignment will start to get the SQL or RSSI level.
4. It will show the alignment result in the “New” box.
5. Click the “OK” button, then the data will be saved and the alignment is finished.



Alignment

5. TX POWER

This parameter is to align the “Power High”, “Power Low3”, “Power Low2” or “Power Low1” for the selected channel.

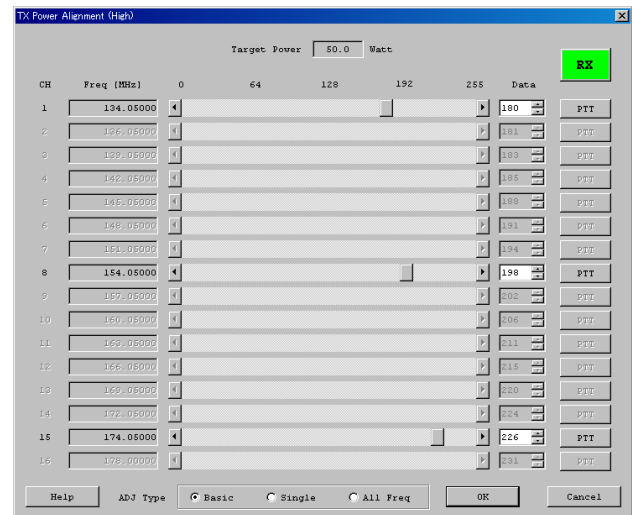
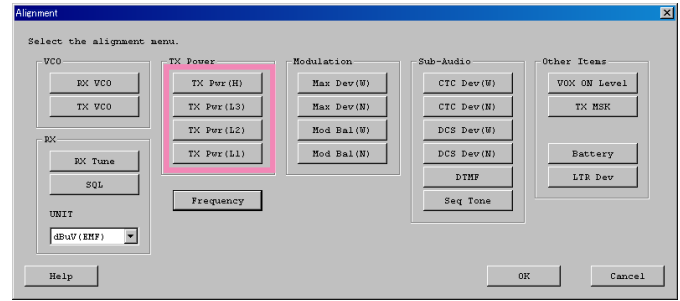
1. Press the “TX Pwr(H / L3 / L2 / L1)” button to start the alignment. The TX Power Alignment window will appear.
2. Click the left mouse button on the slide bar or press the Up / Down arrow key, to select the desired channel.
3. Click the “PTT” button or press the “SPACE” bar at the desired channel, then the radio starts to transmit on the selected channel.
4. Set the value to get desired output power (High: 5 W, Low3: 2.5 W, Low2: 1 W, Low1: 250 mW) on the Power Meter by dragging the slide bar, clicking the up-down button, pressing the left or right arrow key, or entering the value in the entry box on the selected channel.
5. After getting the desired output power click the “PTT” button or press the “SPACE” bar to stop transmitting.
6. Click the “OK” button to finish the TX Power alignment and save the data.

ADJ Type

Basic: “Low-edge / band center / high-edge” and select the channel for alignment (Default).

Single : Alignment value changes only on the selected channel.

All Freq : Alignment value changes on all channels.



Alignment

6. MAXIMUM DEVIATION <WIDE> / <NARROW>

This parameter is to align the “Maximum Deviation” (Wide/Narrow).

It requires the appropriate JIG (Tuning Interface BOX). Connect the JIG and Test Equipment to the radio before the alignment is started.

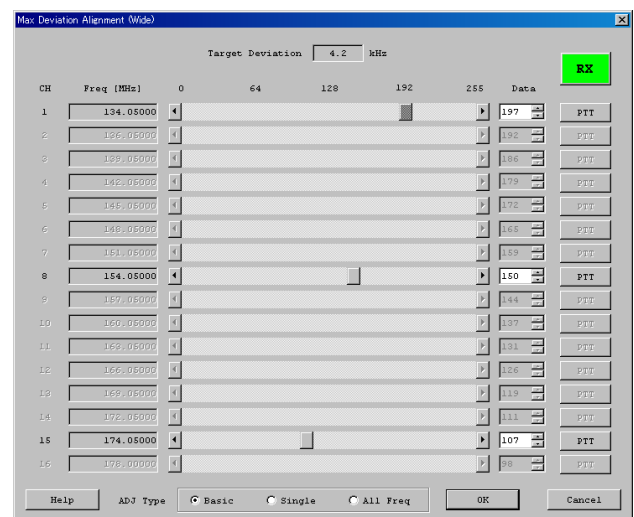
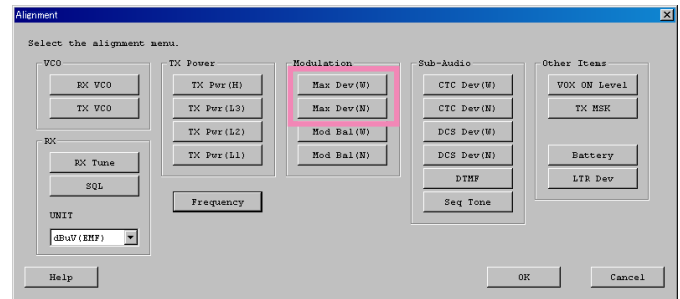
1. Press the “Max Dev (W /N)” button to start the alignment.
2. The Max Deviation alignment window will appear.
3. Connect the Generator, Inject a1 kHz tone / Sine Wave / -10 dBm to the MIC jack.
4. Click the left mouse button on the slide bar or press the Up / Down arrow key, to select the desired channel.
5. Click the “PTT” button or press the “SPACE” bar the radio starts to transmit on the selected channel.
6. Set the value to get desired deviation (Wide: 4.2kHz, Narrow: 2.1kHz) on the deviation meter by dragging the slide bar, clicking the up-down button, pressing the left or right arrow key, or entering the value in the entry box on the selected channel.
7. After getting the desired deviation click the “PTT” button or press the “SPACE” bar to stop transmitting.
8. Click the “OK” button to finish the Max Deviation alignment and save the data.

ADJ Type

Basic: “Low-edge / band center / high-edge” and select the channel for alignment (Default).

Single : Alignment value changes only on the selected channel.

All Freq : Alignment value changes on all channels.



Alignment

Please adjust the following items when needed.

MODULATION BALANCE <WIDE> / <NARROW> (THIS ALIGNMENT IS DIFFICULT.)

This parameter is to align the “Modulation Balance” (Wide/Narrow).

It needs the appropriate JIG (Tuning Interface BOX). Connect the JIG and Test Equipment to the radio before the alignment is started.

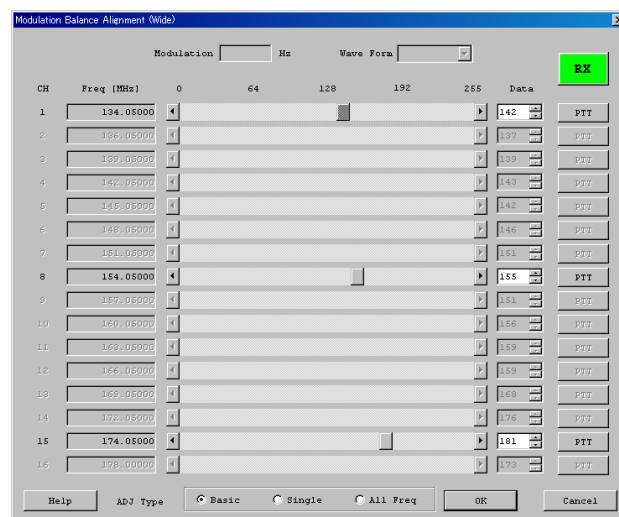
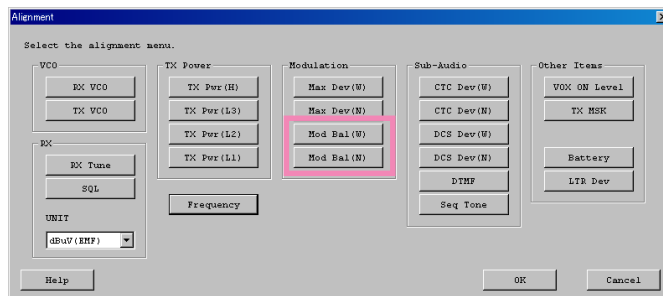
1. Press the “Mod Bal (W / N)” button to start the alignment.
2. The Modulation Balance Alignment window will appear.
3. Connect the Generator, Inject a 400Hz tone / Sine Wave / -10 dBm to the MIC jack.
4. Click the left mouse button on the slide bar or press the Up / Down arrow key, to select the desired channel.
5. Click the “PTT” button or press the “SPACE” bar the radio starts to transmit on the selected channel.
6. Set the value to get “the best square wave” on the Oscilloscope by dragging the slide bar, clicking the up-down button, pressing the left or right arrow key, or entering the value in the entry box on the selected channel.
7. After getting the “the best square wave” click the “PTT” button or press the “SPACE” bar to stop transmitting.
8. Click the “OK” button to finish the Modulation Balance alignment and save the data.

ADJ Type

Basic: “Low-edge / band center / high-edge” and select the channel for alignment (Default).

Single : Alignment value changes only on the selected channel.

All Freq : Alignment value changes on all channels.



Alignment

CTCSS DEVIATION <WIDE> / <NARROW>

This parameter is to align CTCSS Deviation of the selected channel.

1. Press the “CTC Dev (W / N)” button to start the alignment.

The CTCSS Deviation Alignment window will appear.

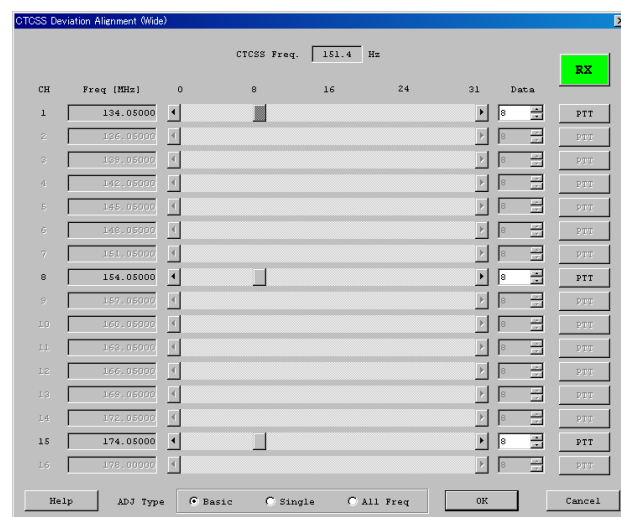
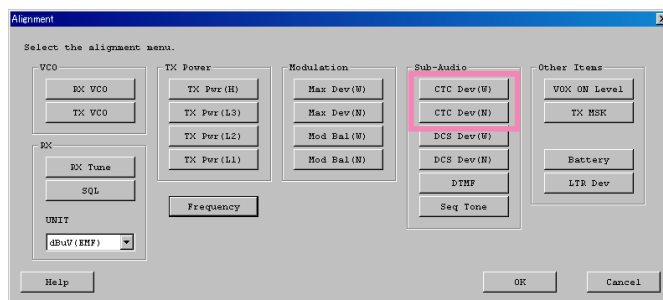
2. Click the left mouse button on the slide bar or press the Up / Down arrow key, to select the desired channel.
3. Click the “PTT” button or press the “SPACE” bar the radio starts to transmit with CTCSS tone on the selected channel.
4. Set the value to get desired deviation on the deviation meter by dragging the slide bar, clicking the up-down button, pressing the left or right arrow key, or entering the value in the entry box on the selected channel..
5. After getting the desired deviation (Wide: 0.6 kHz, Narrow: 0.3 kHz) click the “PTT” button or press “SPACE” bar to stop transmitting.
6. Click the “OK” button to finish the CTCSS Deviation alignment and save the data.

ADJ Type

Basic: “Low-edge / band center / high-edge” and select the channel for alignment (Default).

Single : Alignment value changes only on the selected channel.

All Freq : Alignment value changes on all channels.



Alignment

DCS DEVIATION <WIDE> / <NARROW>

This parameter is to align “DCS Deviation” of the selected channel.

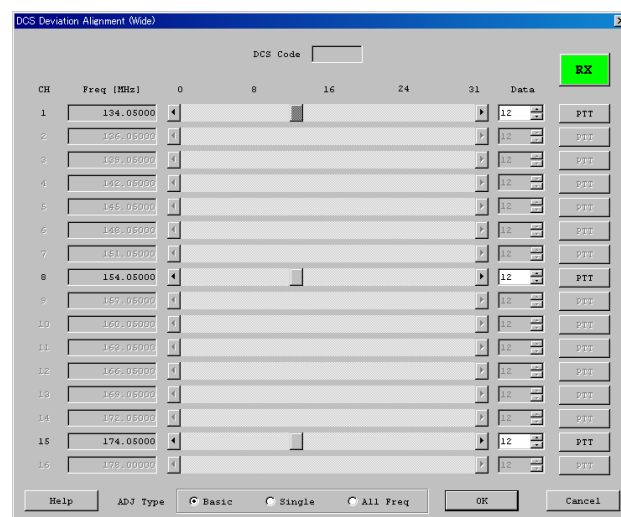
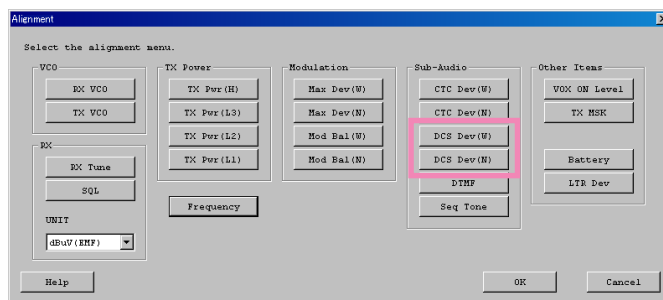
1. Press the “DCS Dev (W / N)” button to start the alignment.
The DCS Deviation Alignment window will appear.
2. Click the left mouse button on the slide bar or press the Up / Down arrow key, to select the desired channel.
3. Click the “PTT” button or press the “SPACE” bar the radio starts to transmit with DCS Code on the selected channel.
4. Set the value to get desired deviation (Wide: 0.6 kHz, Narrow: 0.3 kHz) on the deviation meter by dragging the slide bar, clicking the up-down button, pressing the left or right arrow key, or entering the value in the entry box on the selected channel.
5. After getting the desired deviation click “PTT” button or press “SPACE” bar to stop transmitting.
6. Click the “OK” button to finish the DCS Deviation alignment and save the data.

ADJ Type

Basic: “Low-edge / band center / high-edge” and select the channel for alignment (Default).

Single : Alignment value changes only on the selected channel.

All Freq : Alignment value changes on all channels.

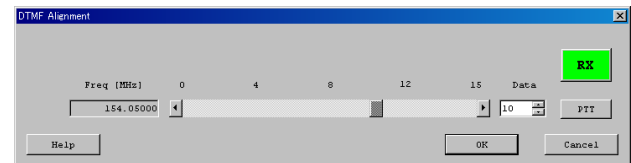
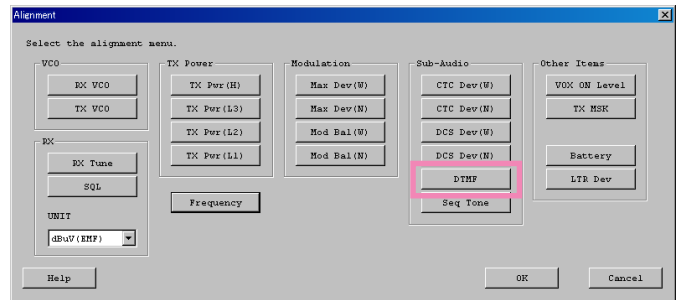


Alignment

DTMF DEVIATION

This parameter is to align “DTMF Deviation”.

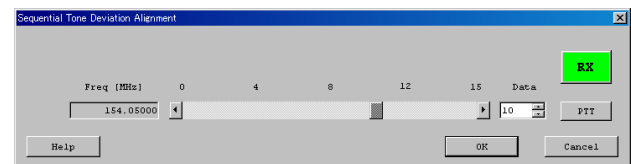
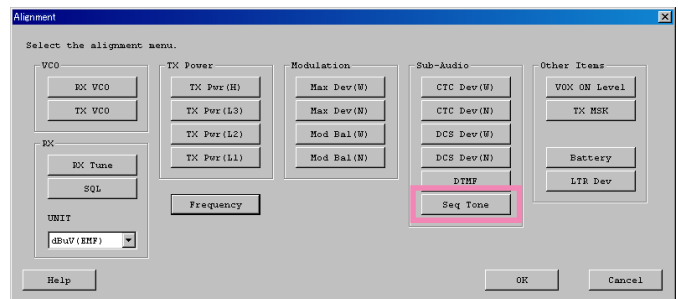
1. Press the “DTMF” button to start the alignment.
The DTMF Alignment window will appear.
2. Click the “PTT” button or press the “SPACE” bar the radio starts to transmit on the Center frequency channel.
3. Set the value to get desired deviation (3.0 kHz) on the deviation meter by dragging the slide bar, clicking the up-down button, pressing the left or right arrow key, or entering the value in the entry box.
4. After getting the desired deviation click the “PTT” button or press the “SPACE” bar to stop transmitting..
5. Click the “OK” button to finish the DTMF Deviation alignment and save the data.



SEQUENTIAL TONE DEVIATION

This parameter is to align “Sequential Tone Deviation”.

1. Press the “Seq Tone” button to start the alignment.
The Sequential Tone Deviation Alignment window will appear.
2. Click the “PTT” button or press the “SPACE” bar the radio starts to transmit on the Center frequency channel.
3. Set the value to get desired deviation (3.0 kHz) on the deviation meter by dragging the slide bar, clicking the up-down button, pressing the left or right arrow key, or entering the value in the entry box.
4. After getting the desired deviation click the “PTT” button or press the “SPACE” bar to stop transmitting.
5. Click the “OK” button to finish the Sequential Tone Deviation alignment and save the data.



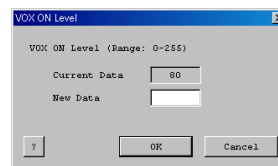
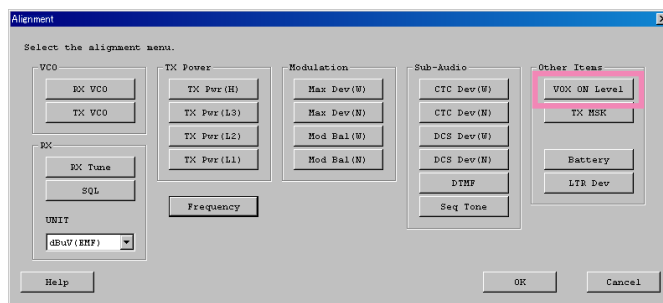
Alignment

VOX ON LEVEL

This parameter is to align the “VOX On Level”.

Set the Sensitivity of the VOX circuitry's input audio detector.

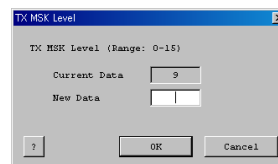
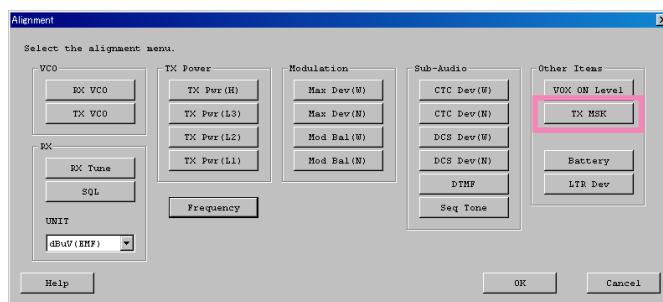
1. Press the “VOX ON Level” button to start the alignment.
The VOX ON Level window will appear.
2. Then input the alignment value in the “New” box.
Default: 80
Input Range: 0 (Level Down) ~ 255 (Level Up)
3. Click the “OK” button, the data will be saved and the alignment is complete.



TX MSK LEVEL

This parameter is to align the modulation level of the ANI function.

1. Press the “TX MSK” button to start the alignment.
The TX MSK Level window will appear.
2. Then input the alignment value in the “New” box.
Default: 9
Input Range: 0 (Level Down) ~ 15 (Level Up)
3. Click the “OK” button, the data will be saved and the alignment is complete.



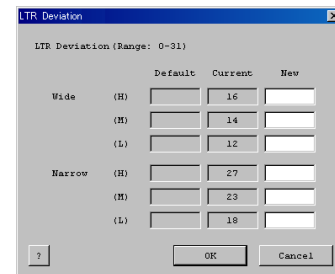
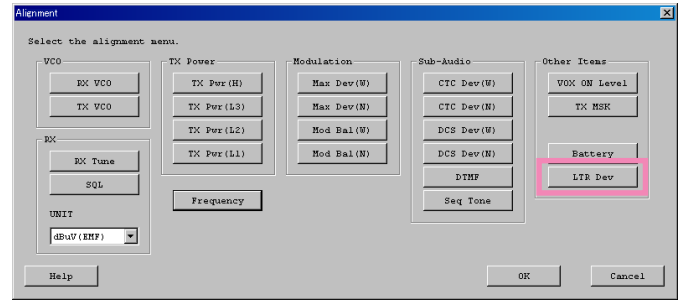
Alignment

LTR DEVIATION

This parameter is to align the “LTR Deviation”.

This parameter does not appear when adjusting the transceiver which is not installed the LTR feature.

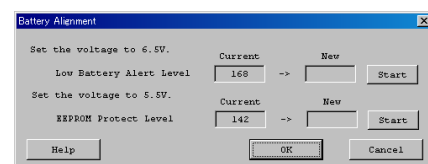
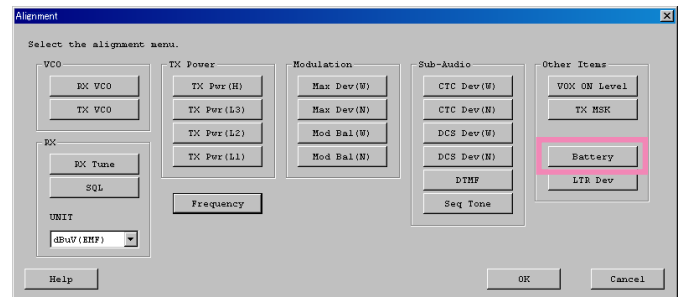
1. Press the “LTR Dev” button to start the alignment.
The LTR Deviation window will appear.
2. Then input the alignment value in the “New” box.
Input Range: 0 (Level Down) ~ 31 (Level Up)
Important Note: You must input a value in the all boxes, even if you do not want to change all other values. When you click the “OK” button without entering any values, the current values becomes “0”. Inputs the current value to the box which you do not want to change.
3. Click the “OK” button, the data will be saved and the alignment is complete.



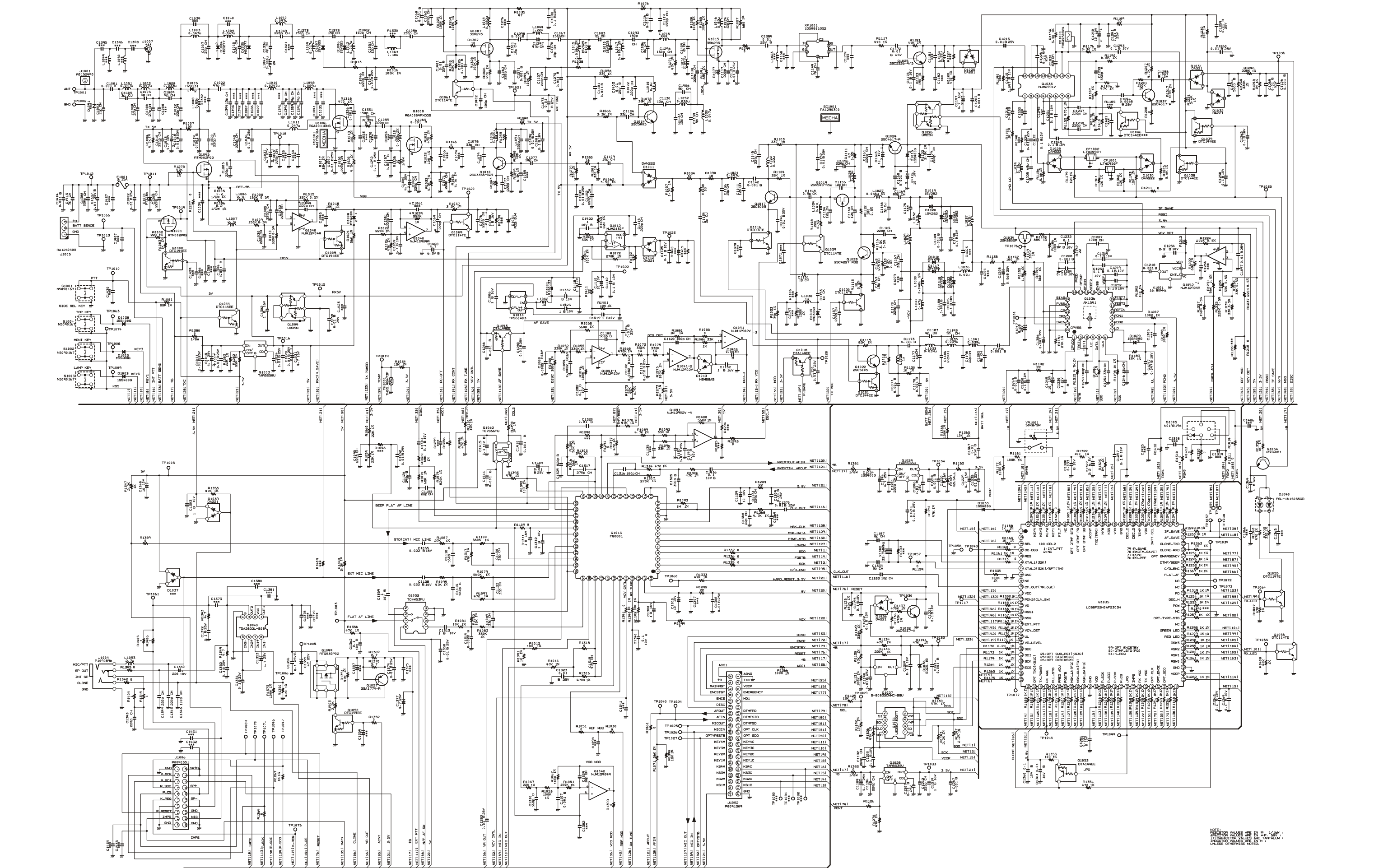
BATTERY

This parameter is to align the “Low Battery Alert Level” and “EEPROM Protect Level” voltage. When the DC power source voltage drops below the “EEPROM Protect Level” voltage, the radio will stop writing data to the EEPROM to prevent erroneous writing.

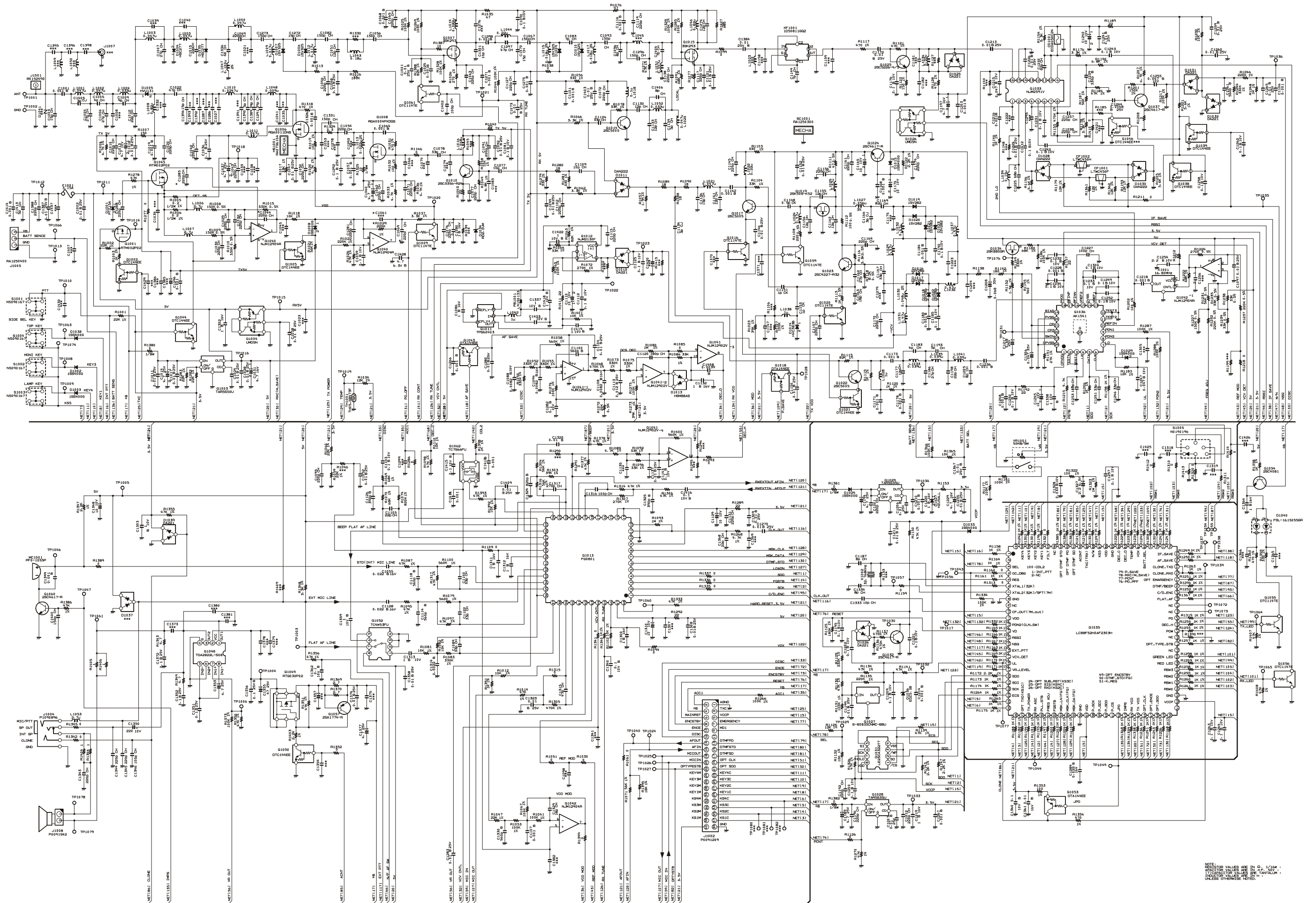
1. Set the value of the DC Power source to 6.5V (according to the indication) and click the “Start” button.
The new alignment value will show in the “New” box.
2. Set the value of the DC Power source to 5.5V (according to the indication) and click the “Start” button.
The new alignment value will show in the "New" box.
3. Click the “OK” button, the data will be saved and the alignment is complete.
4. Set the value of the DC Power source to 7.5V (according to the indication).



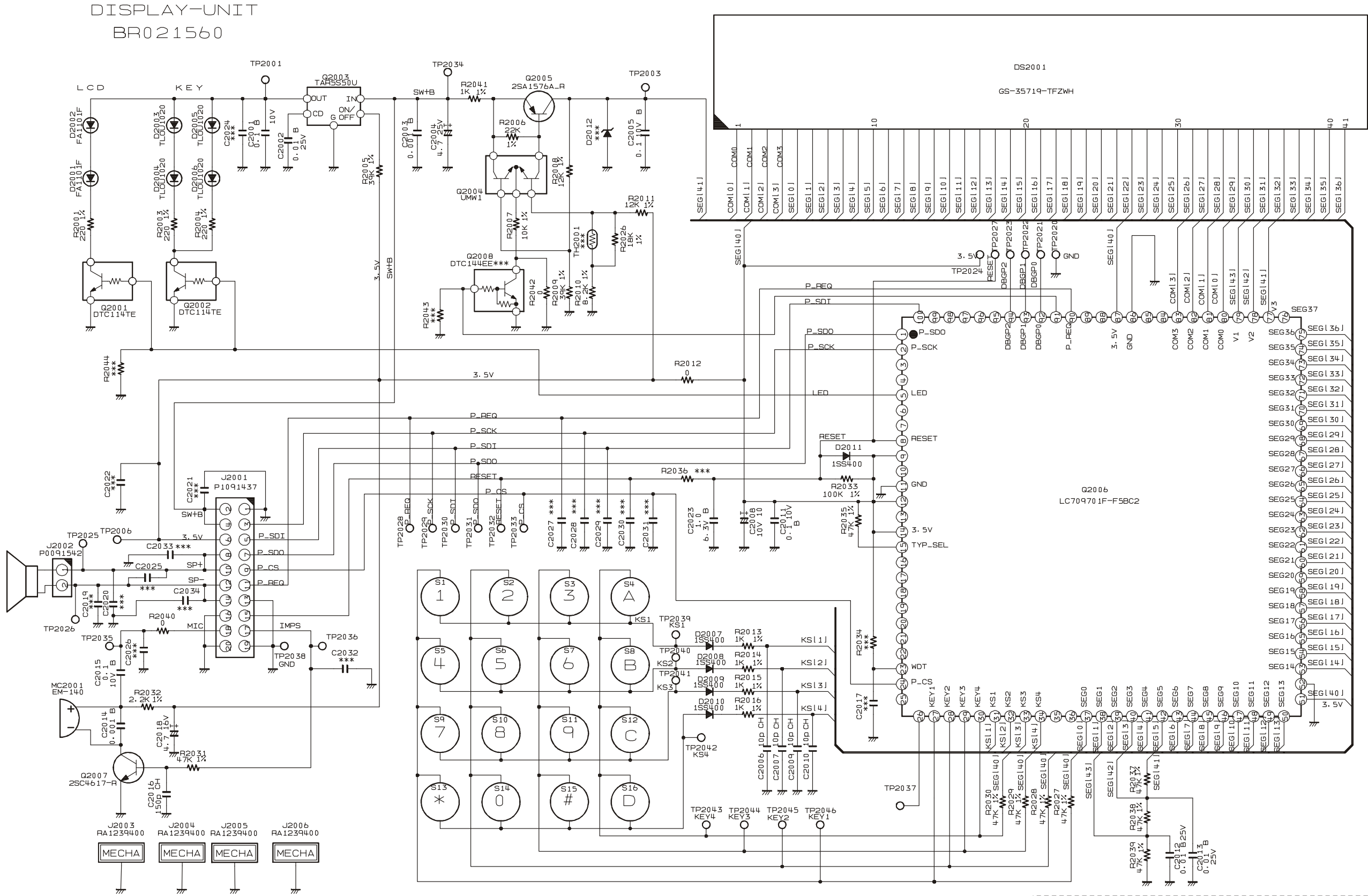
MAIN Unit Circuit Diagram (16 key & 4 key Type)



MAIN Unit Circuit Diagram (Non-key Type)



DISPLAY Unit Circuit Diagram (16 key & 4 key Type)



NOTE:
RESISTOR VALUES ARE IN Ω , $1/16W$;
CAPACITOR VALUES ARE IN μF , $50V$;
(T)CAPACITOR VALUES ARE TANTALUM ;
INDUCTOR VALUES ARE IN H ;
COILES VALUES ARE IN H ;
UNLESS OTHERWISE NOTED.



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